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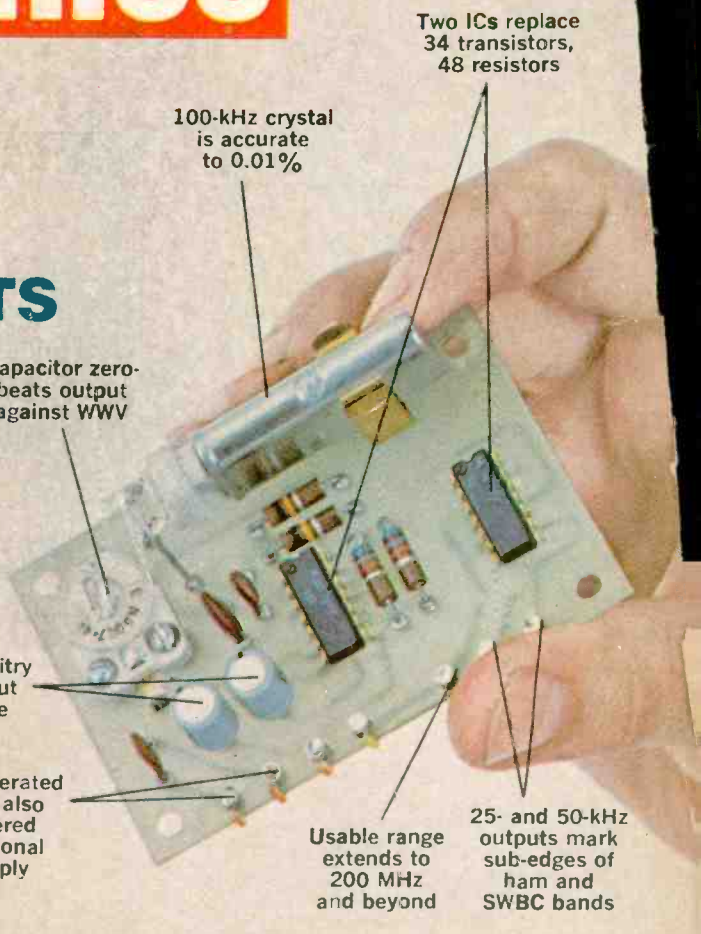

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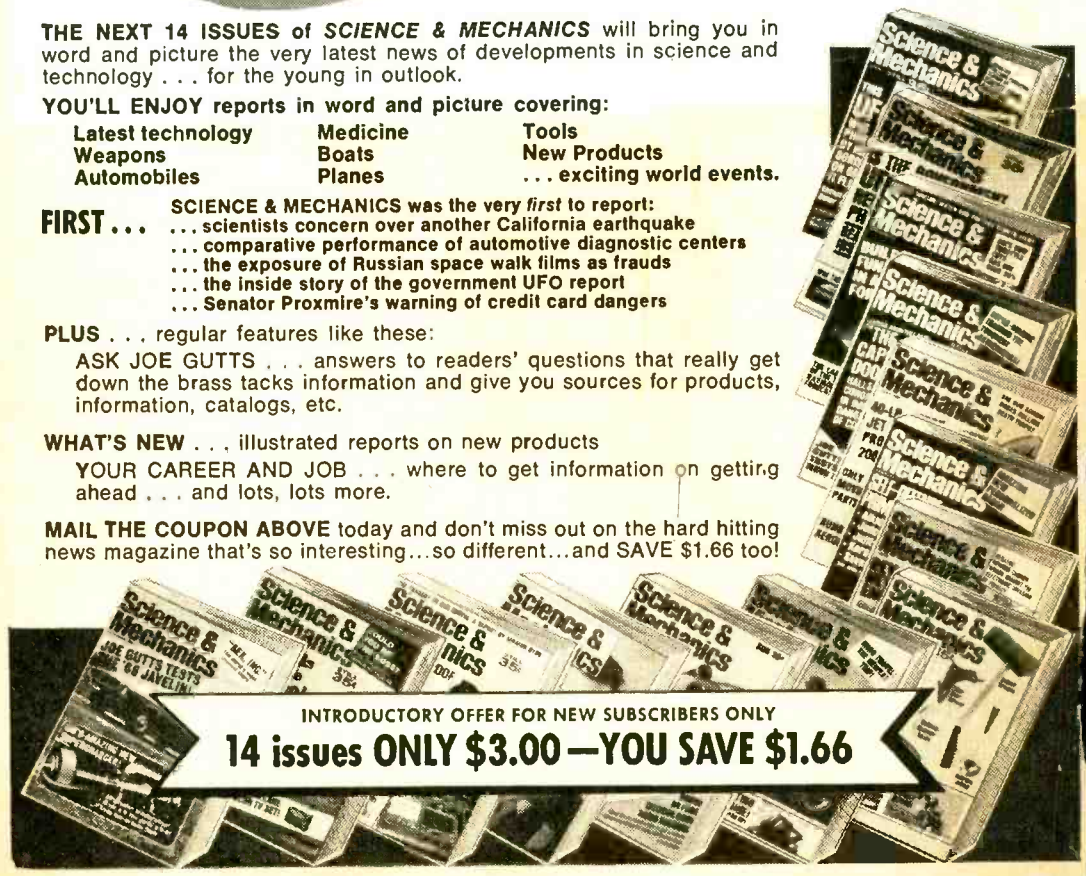

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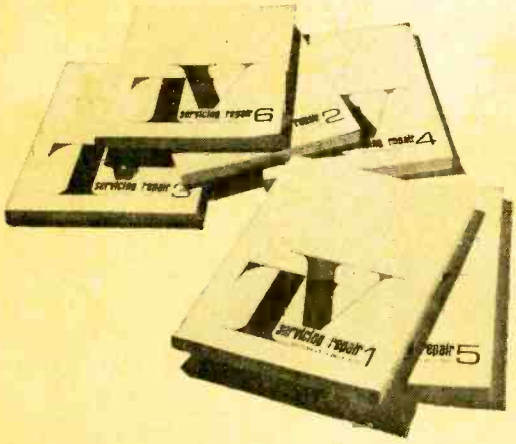

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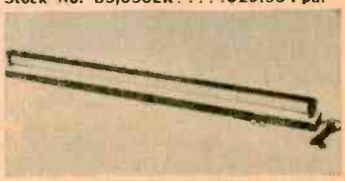

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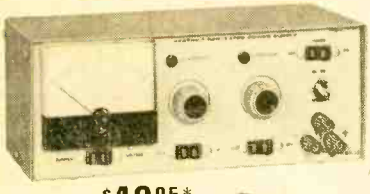

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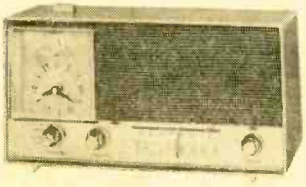

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From The Leader

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GRA-295-4, Mediterranean Cabinet shown **$124.95***

Heathkit "295" Color TV

With Optional RCA Matrix Tube . . . with the same high performance features and built-in servicing facilities as GR-681 above . . . less AFT, VHF power tuning and built-in cable-type remote control. You can add the optional GRA-295-6 Wireless Remote Control at any time. New optional RCA Matrix tube doubles the brightness, Model GR-295MX, $485.00.

GRA-295-1, Contemporary Walnut Cabinet shown **$64.95***

Both the GR-681 and GR-295 fit into the same Heath factory assembled cabinets; not shown Early American style at $109.95*

NEW Deluxe Heathkit "581" Color TV With AFT

The new Heathkit GR-581 will add a new dimension to your TV viewing. Brings you color pictures so beautiful, so natural, so real . . . puts professional motion picture quality right into your living room. Has the same high performance features and exclusive self-servicing facilities as the GR-681, except with 227 sq. inch viewing area, and without power VHF tuning or built-in cable-type remote control. The optional GRA-227-6 Wireless Remote Control can be added any time you wish. And like all Heathkit Color TV's you have a choice of different installations . . . mount it in a wall, your own custom cabinet, your favorite B&W TV cabinet, or any one of the Heath factory assembled cabinets.

GRA-227-2, Mediterranean Oak Cabinet shown **$109.95***

Heathkit "227" Color TV

Same as the GR-581 above, but without Automatic Fine Tuning . . . same superlative performance, same remarkable color picture quality, same built-in servicing aids. Like all Heathkit Color TV's you can add optional Wireless Remote Control at any time (GRA-227-6). And the new Table Model TV Cabinet and roll around Cart is an economical way to house your "227" . . . just roll it anywhere, its rich appearance will enhance any room decor.

GRS-227-5, New Cart and Cabinet combo shown **$54.95***

Both the GR-581 and GR-227 fit into the same Heath factory assembled cabinets; not shown, Contemporary cabinet $64.95*

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The new Heathkit GR-481 has all the same high performance features and exclusive self-servicing aids as the new GR-581, but with a smaller tube size . . . 180 sq. inches. And like all Heathkit Color TV's it's easy to assemble . . . no experience needed. The famous Heathkit Color TV Manual guides you every step of the way with simple to understand instructions, giant fold-out pictorials . . . even lets you do your own servicing for savings of over $200 throughout the life of your set. If you want a deluxe color TV at a budget price the new Heathkit GR-481 is for you.

GRA-180-1, Contemporary Walnut Cabinet shown **$49.95***

Heathkit "180" Color TV

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GRS-180-5, Table Model Cabinet & Cart combo **$42.50***

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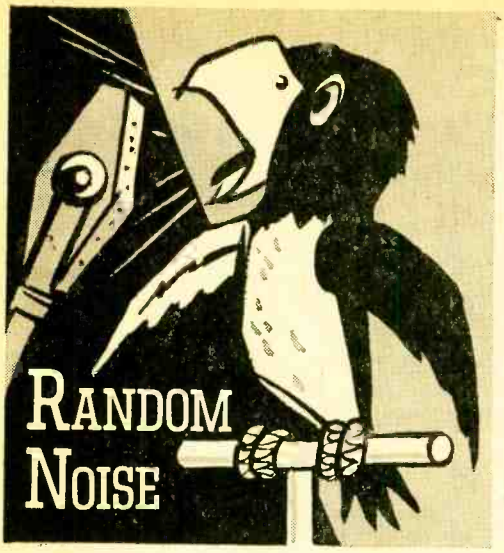
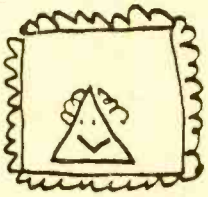


By Julian M. Sienkiewicz, Editor

Would you believe? Omar Mung has taken over Elementary Electronics! Readers who did not read pages 46 through 48 of our September/October issue have missed the Mung revolution. Mungs have replaced Kilroy signs in the field of electronics. So get with it and discover the work of Mung.

We asked our readers to send in their favorite Mung and in return we will award the best Mung a shortwave receiver. Additional prizes will be awarded to a few runner-ups. Well, the mail is fantastic and our Mung Evaluation Board is up to their ears in entries. Since the mail has not let up, we've decided to keep the contest open a bit longer. So don't wait. Conjure up your favorite Mung and mail it today to Mung Editor, Elementary Mungtronics, 229 Park Ave. South, New York, N. Y. 10003. *All entries must be postmarked on or before December 15, 1969.*



Munga Lisa

A few Mungs are scattered on this page to give you an idea of what is a Mung. These Mungs are old—that is, they existed before the contest started. Think up an original Mung as did Buddy Cavitt of Medford, Ore., with his *Julian Mungkiewicz* (at right), your Mung Editor. Good try, Buddy—you got one sure vote for first prize!

Flying Mung

No Mung on Moon! Here's an interesting item from the August 6th edition of the *Chicago Daily News* that'll aMung you:

Astronaut Neil Armstrong said he "thoroughly enjoyed" replicas of members of the Mung Dynasty sent him by a group of Great Lakes sailors, even though he couldn't meet their request to put a Mung on the moon.

Mungtini

The commander of the Apollo mooncraft sent his regrets to the men at the Electronics Technicians School at Great Lakes Naval Training Center, who claim credit for creating Omar Mung, the modern equivalent of World War II's Kilroy, who appears daily in The Daily News.

"Thank you for writing to me to request that I carry a replica of your mascot, Omar Mung, with me to the lunar surface," Armstrong wrote school director Lt. Cmdr. W. H. Wheeler.

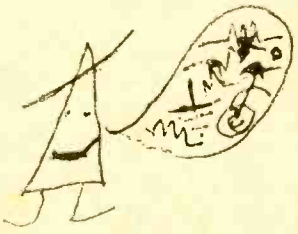
"I regret that I will be unable to do so, but requests of this nature are so numerous that I am unable to honor any of them. However, I thoroughly enjoyed the pictorial representations of Omar's many faces and titles," Armstrong added.

Mungconi

Too bad, Neil Armstrong, you could have put the first Mung on the Moon!

Munger

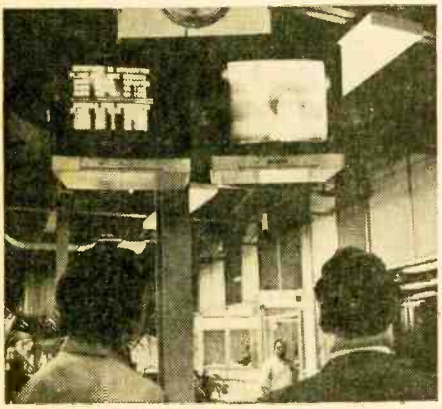
The Astro Parade. Now that the U.S. Moon Shot is in the history books, let's take a look at the parade of companies that advertise their roles in the Apollo program. If a widget made it on *Eagle,* you can bet your last lunar dollar that Widget, Inc. and their holding company, U.S. Widget Corp. of America, ran ads in trade and consumer papers hoping that some of the magical lunar dust will land on their tails. From this poor Editor's seat, it appears that NASA should add a stipulation to its contracts limiting or eliminating all reference to space shoots unless said company either makes outright contributions to the space effort (that means no charge or at cost only) or pays NASA for the privilege of making such references. After all, why should three brave men risk their lives only to have their pictures in some company's ad campaign? ■



Making a Mung is fun as Buddy Cavitt of Medford, Ore. discovered with his Julian Mungkiewicz.

The Pre-Flight Channel

The "unseen voice" that announces Air Shuttle arrivals, departures, and special information at Eastern Airlines' LaGuardia terminal in New York will now be seen on a closed circuit television system throughout the terminal. A recently installed Raytheon television system enables ground hostesses to provide personal contact with passengers and those waiting in the terminal. When the hostesses are not "on the air," the television monitors in the experimental system carry routine video messages on flight arrivals, departures and gate numbers. The system can be used to televise a message directly to a particular gate or area or throughout the entire terminal.



Raytheon closed circuit television installation at Eastern Airlines' Air Shuttle terminal at LaGuardia airport in New York adds a face to the "unseen voice" reporting arrivals, departures and other information for travelers.

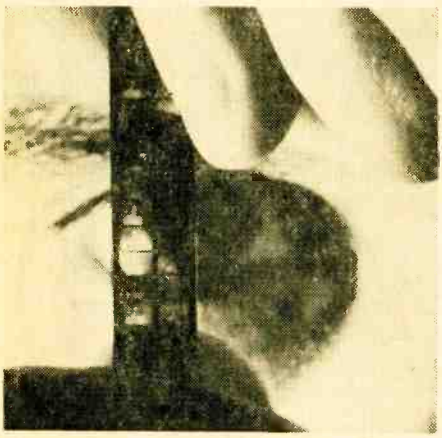
Introducing EVR

In the same way that a long-playing record stores sound conveniently and inexpensively on

a record for later replay on standard phonographs, EVR (Electronic Video Recording) stores pictures with sound for playback through a standard television set. Any motion picture, videotape or live television presentation can be recorded for distribution on EVR.

Basically, there are three elements to an EVR system:

1. *The thin EVR film* is dual-tracked, and carries its sound in parallel lines on a magnetic



This is EVR film consisting of two side-by-side tracks, each with a capacity of 26 minutes of black-and-white programming and an independent sound track. Notice that there are no sprocket holes to wear or damage the film.

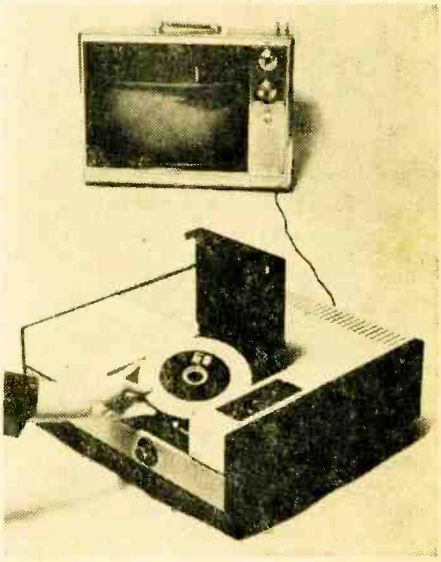
track, along with two rows of visual frames. Although the film is miniaturized, the image reproduces with sharper definition and clarity than a conventional television picture. The film has no sprocket holes, thus eliminating the chances of tearing. As further protection against damage or deterioration, a tiny cushion of air separates the layers of pictures when stored in the cartridge.

2. *The circular EVR cartridge,* which holds the film, is seven inches in diameter and has a maximum capacity of 750 feet of film, 8.75 mm (under ⅜ inch) wide. This is equivalent to 180,000 picture frames or 52 minutes of programming.

3. *The EVR player* is compact, versatile and simple to operate. A lead from the player is easily attached by handclips to the external antenna terminals of the television set. Then the film cartridge is placed on the player, the television set turned on to a channel that is not broadcasting, and the player starter button pushed. The film automatically threads itself past an electronic sensor that converts the film image to electrical impulses, and then transmits these impulses—along with the sound—into the television set. The player features buttons for speedy forward and rewind, a fingertip adjustment for slow scanning of individual sequences, and the capability for freezing any frame on the screen without damaging the film or dimming, flickering or blurring the image.

Since transmission to the set is direct and there are no buildings or other interference to contend with, there is no ghost image or other picture or sound distortion. Nor is there any projector noise to distract the viewer or interfere with concentration, conversation, comment or supplementary instruction. The system can also be operated in normal light without lowering the shades.

Although much of the EVR technology was developed by Dr. Peter C. Goldmark, president and director of research at CBS Laboratories, as an offshoot of the Division's space research programs with the U.S. Government, CBS will not manufacture the system itself. CBS will license its production among leading manufacturers. At first, players will appear as attachment units, styled and built by manufacturers of home entertainment equipment. Once manufacturers get into full production, customers will be offered a variety of models with complete cartridge interchangeability. The film, however, will be recorded, printed and inserted in cartridges at CBS plants.



Placing the EVR film cartridge in position is as easy as it appears. The EVR player is readily connected to any conventional television set by a single wire.

Electronic Video Recording will give new scope to television's immense potential in education. As the Carnegie Commission for Educational Television noted, a more versatile playback technology in educational television is the one thing needed to return to the classroom the

flexibility that the present uses of broadcasting deny it. With such a technology, according to the commission, "the teacher can select the program, play it at the moment of his own choosing, replay it at will in whole or in part, interrupt it for comments." By providing this technology, EVR can help educational television make the "massive contribution to formal education" that the Carnegie Commission feels is not only possible, but is imperative.

Today, teachers must schedule classwork around broadcast hours, and they have no control over what appears on the screen—or when. With EVR, the teacher can integrate educational films more effectively into the smooth flow of his classwork. He can preview and choose. He can stop the program for comment or for general discussion. He can schedule lessons at his own discretion, and show his films either to individual students or to large groups simply by linking a single EVR player into as many television sets as he needs. He can even play them in several classrooms at once.

The process of education does not end when one leaves school. It is only just beginning. The swift pace of change in science, technology, the arts and industry forces millions of Americans to study at home, and many actually enroll in formal correspondence courses to sharpen and extend their skills.

X Out X-Rays

A high-voltage diode that prevents X-ray radiation from color TV sets, in addition to providing excellent voltage regulation in the newer-generation transistorized TV circuits, is now available for 1970 model design. The new

"You say you live in a lighthouse? Here's just the setup for you!"

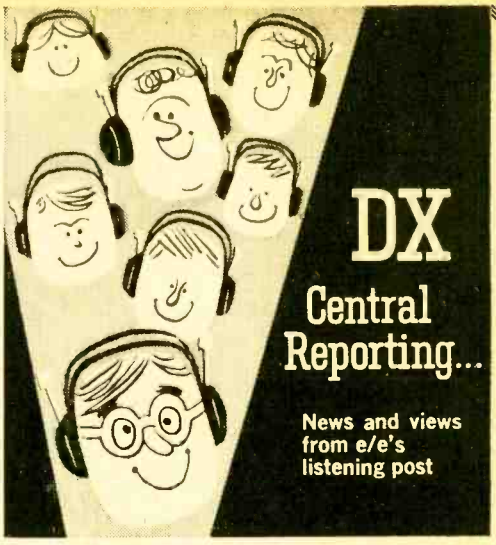
diode has particular appeal to color TV manufacturers in view of the recently imposed Federal legislation compelling adherence to a still-to-be-set standard for a maximum acceptable radiation level. A retrofit kit, now in the late stages of design, offers a simple means of protecting *present* production model TV sets, as well as approximately 25 million color sets already in the homes of consumers.

The high-voltage diode operates as a simple shunt regulator, conservatively rated to pass a maximum operating current of 3.0 mA. Regulation is one kV from 0.1 to 1.2 mA. at an operating voltage of 25 kV. By its physical nature, the diode does not produce X-rays itself. Moreover, it exhibits a unique fail-safe characteristic that prevents radiation from still another source: the face of the picture tube. When conventional voltage regulators fail, they cause a much-higher-than-normal voltage to be imposed on the face of the TV picture tube. This abnormally high potential can result in X-rays passing through the face of the picture tube and the protective glass front of the set. In contrast, if the Victoreen high voltage diode should fail, a safe, lower-than-normal voltage is imposed on the picture tube.

Diodes have only two connections and are basically simple devices. This simplicity carries over into the operational characteristics and the design of high voltage circuits in TV sets.

The high-voltage diode was developed by Victoreen Instrument Division, Victoreen Leece Neville, Inc., of Cleveland, Ohio.

New Victoreen Instrument diode will eliminate color TV set X-ray radiation. Designed for set makers to build into 1970 models and to fit many existing sets.



by Don Jensen

☐ A few months ago we looked at stations operating from the vital Persian Gulf area. Response to this column suggests that DXers are interested in other broadcasts from the volatile Middle and Near East.

Many SWLs prefer those stations which broadcast in English. Here are a few of the easier ones from this global hot spot.

Station	Country	kHz	GMT
Radio Cairo	UAR	9,475	0200
Kol Israel	Israel	9,009	0400
Radio Amman	Jordan	9,560	1600
Radio Beirut	Lebanon	11,820	0230
BBC Relay	Cyprus	11,955	0300
Syrian B.S.	Syria	15,165	2030
Radio Ankara	Turkey	15,160	2200
Radio Kuwait	Kuwait	15,405	1600
Radio Iran	Iran	17,738	2200

Too easy? Try these!

Widely mentioned in the newspapers lately, but not reported by SWLs, is a special program aired by Iraq's Radio Baghdad. The foreign correspondents call this one *The Voice of the Storm*. It's a propaganda program prepared by Al Assifa, the military wing of the Palestine National Liberation Movement, Al Fatah.

بمناسبة الذكرى الأولى لمعركة الكرامة ٢١ آذار مارس ١٩٦٩

For four years, but especially since the Six Day War of June 1967, Al Assifa's fedayeen (guerrillas) have conducted military and sabotage raids into Israel from camps in Jordan, Syria and Egypt. Their avowed aim is to free Palestine (Israel) through armed struggle.

According to Fatah leader, Abu Amar, "Public relations and the circulation of information has not been one of our strong points—we are primarily an action organization." Amar says, however, that Fatah hopes to better explain its case to the world when it has the necessary money and material.

Until then, it relies mostly on the single program over Radio Baghdad, which is broadcast daily from 1830 to 1915 GMT in Arabic; 1915 to 1930 in Hebrew. Frequencies haven't been announced, but you might try 6,155, 7,180 or 9,555 kHz., as conditions permit. Reports of this program may go to Radio Baghdad, or to Al Fatah, 18 Boulevard du Colonel Amirouche, Algers, Algeria.

We're Right! Yes, Virginia, there is a *Voice of the Coast*! In an earlier column we mentioned receiving conflicting information about a station in Sharjah, one of the Trucial States. Official British sources now confirm that the *Voice of the Coast* is active on 6,040 kHz., with a 10 kilowatt shortwave transmitter.

It's located at the headquarters camp of the Trucial Oman Scouts, a British-officered constabulary, about four miles from the only town in this barren sheikdom. Its all-Arabic programming supposedly is aimed at domestic audiences, but we feel that there's more than meets the eye here. Overseas monitors have heard the *Voice of the Coast*—its tongue-tangling Arabic ID is "Sawt as-sahil min al-imarat al-mutasalihah," it's said—around 0230 and 1500 GMT. As far as we know, it hasn't been logged stateside yet.

And medium wave DXers are chasing the new BBC Eastern Relay station. Moved from Aden's Perim Island to Masirah, another island in the Arabian Sea off Muscat and Oman, it uses new and ultra-powerful broadcast band transmitters. This is *tough*, but we bet some east coast sharpie will get this on 700-701 kHz. this winter.

Tip Topper. East of New Guinea lies the island of Bougainville. Geographically part of the British Solomon Islands, Bougainville's administration, however, is Australian, under a UN trust mandate. Until last year the island had no broadcasting station of its own.

Other radio services didn't really meet the needs of the people, so Australian authorities decided to establish a local station, Radio Bougainville. On April 20, 1968, a two kilowatt shortwave outlet officially opened at Kieta, the main town.

Most programs are in pidgin English, the strange lingua franca of the islands. Broadcasts include newscasts, health, agricultural and edu-

cational features. Local songs, many of them specially recorded on Bougainville by the station staff, and American country and western music are popular. The station is administered by an Australian radio officer, but the half dozen or so announcers are all local people trained at Port Moresby.

Low power and an early, early sign off made Radio Bougainville a hard one to hear in the U.S. But recently, DXers have been reporting improved signals on 3,322.5 kHz. One reason is that the station now has extended its schedule to 1200 GMT, a more favorable hour.

Radio Bougainville verifies accurate reports with the same attractive and information-packed QSL folder used by the other administration broadcasting stations in Papua and New Guinea.

Bandsweep. 834 kHz.—Radio Belize, British Honduras, has been regularly logged by a Cicero, Ill., listener, sometimes nearly obliterating WCCO, Minneapolis, during the evening. **4,777 kHz.**—Libreville, Gabon, has been in the news recently as one of the originating points for the supply airlift to Biafra. Libreville's SW outlet can be heard around 0500 GMT. **4,845 kHz.**—Another African, Radio Botswana has an English language newscast at 0430 GMT. **6,045 kHz.**—Panamanians have been as scarce as hen's teeth for several years, but La Voz del Baru is now being logged around 1030 GMT with typical Latin American programming. **7,301 kHz.**—Amazing Radio Biafra, with its Swiss-made, 10 kw. portable transmitter, often puts in decent signals after 0500 GMT. **9,520 kHz.**—The voice of one of Peru's major newspapers, Radio La Cronica is a good bet on some nights. All in Spanish, of course. **11,825 kHz.**—Strongest signal in years, says a Canadian listener about Tahiti's shortwave outlet. Does well until 0800 GMT sign off. **21,740 kHz.**—Seldom venture this high on the dial? Try Radio Australia's North American beam around 0100 GMT.

(Credits: John Czupowski, Ill.; Dan Ferguson, Fla.; Leslie Marcus, N.B., Canada; A. R. Niblack, Ind.; Gregg Calkin, N.B., Canada; Dick Heggs, B.C., Canada; North American Shortwave Association)

Radio Rebelde. Every SWL knows the mighty voice of Fidelismo, Radio Havana Cuba. Cuban propaganda programs are widely heard (if little listened to) in North America. But in the southern half of this hemisphere their impact probably is greater. In steamy Brazilian river towns, in Indian barrios high in the Andes, the now commonplace transistor radios often are tuned to Havana's powerful stations.

These broadcasts originate from transmitters at Cayo La Rose, site of a former textile factory near the town of Benta, 23 miles west of Havana. When built in 1961, the whole installation—Swiss transmitters, Czech broadcasting equipment and all—was valued at $35 million. The investment is even greater now. But Castro's radio was not always so plush. In fact, his first attempt at shortwave broadcasting was a flop!

From November 1956, when Fidel and 80 followers splashed ashore near Niquero, until late the following year, the revolt against the Batista regime struggled along. Striking from mountain camps, constantly on the move, the rebels of the 26th of July Movement were in no position to begin clandestine broadcasting. Their radio gear consisted of some captured Cuban army transmitters, plus 20 walkie-talkies smuggled in from the U.S. with the help of an official in Batista's public works ministry. It was used only for short-range field communications.

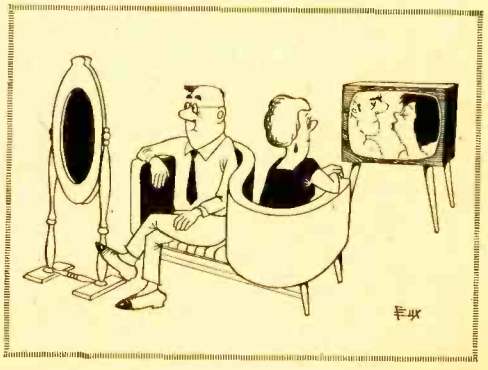
But after 14 months of fighting, Castro felt ready to start broadcasting to the Cuban people. According to the late "Che" Guevara, he broadcast the first program early in February 1958, from a hidden encampment high in the Sierra Maestra Mountains.

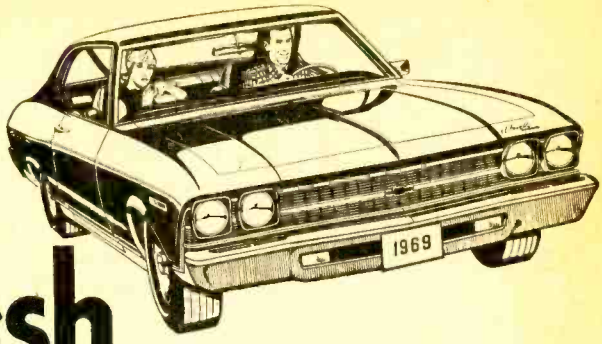
A radio technician lashed together a semi-portable station, using a revamped amateur band transmitter. But, said Che, the first try was something less than a success. The audience totaled just two—a farmer who lived a few hundred feet across the dusty road, and Castro, himself, who had the only receiver in the rebel camp.

A few days later, on February 23, world headlines reported that Castro supporters in Havana had kidnapped famed race driver Juan Fangio to dramatize their struggle. That same evening, a lesser known, but more important development occurred high in the Sierra Maestra. Transmission bugs worked out, the makeshift station began regular operations.

Crackling across the 40-meter ham band, from Oriente to Pinar del Rio, went the call—"Aqui Radio Rebelde, transmitiendo desde la Sierra Maestra en territorio libre de Cuba!"

A far cry from today's propaganda mill, still that broadcast marked the real beginning of Fidel Castro's radio voice. ■





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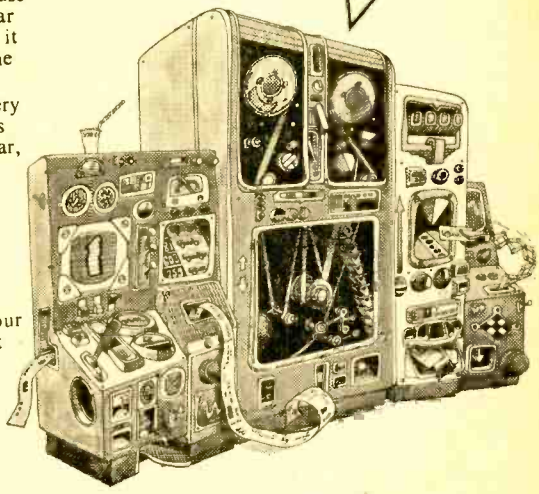
National features GM cars. They're fresh, because we generally trade 'em every 6 months. But a car isn't any good to you if it isn't where you want it when you want it. That's why we hired Max, the million dollar computer.

Max knows where every one of our cars is. Every minute. Call us anytime, from anywhere, at this toll-free number—800-328-4567. Ask us for a car, and we'll ask Max what's available. Thanks to him, we *know* instantly. The best our big name competitors can do is guess. That's why only National can guarantee reservations.

Of course, we still toss in the free S&H Green Stamps at all our 1800 locations. Our trusting nature permits us to accept any recognized credit card. Add all that to our GM cars and our plot to make the customer No. 1, and we think you'll like renting from us.



NATIONAL CAR RENTAL

We make the customer No. 1.

Hey Mable! Packaged Cable!

Now you can buy your coaxial cable in handy dandy packages, thanks to Amphenol. The line includes pretested RF cable assemblies most used by communications experimenters, CBers, and hams. Pictured, for example, is a 20-ft. length of RG-58/U type polyfoam cable with Astroplated PL-259 connector on one end, spade lugs on the other. So now you don't have to bother with the salesman measuring and cut-

Amphenol Packaged Coaxial Cable Assembly

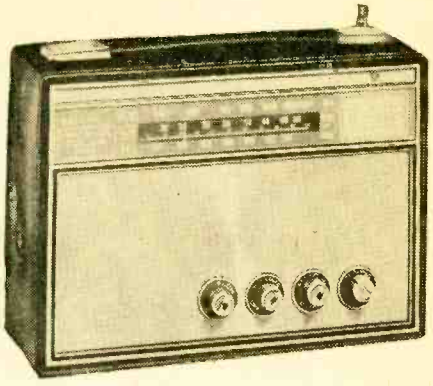
ting short lengths of cable and searching bins for the proper coax connector. There's also a 3-ft. package, ideal for use as a patch cord or communications jumper cable, between radio transceivers and linear amplifiers, coaxial switches, test equipment, etc. Other lengths go from 12 to 100 ft. Prices and literature available from Amphenol Distributor Div., Bunker-Ramo Corp., 2875 S. 25th Ave., Broadview, Ill. 60153.

We the People Want Public Service

Included in Channel Master's new line of public service band communications receivers is Model 625A, which covers the 30-50 MHz low band and the 147-174 MHz high band. It has three separate tuner and converter circuits

★★★★★★★★★★★★★★★★★★★★★

with four IF stages for best sensitivity, selectivity, and signal-to-noise ratio. It operates on batteries or AC through a built-in power supply and battery rejuvenation circuit. The 6252A fea-

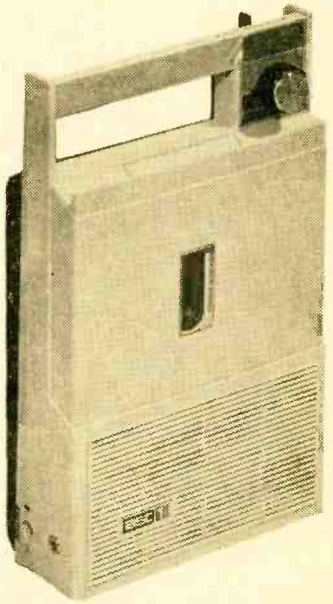


Channel Master 6252A Police-Public Service Band Receiver

tures variable squelch, and is supplied with an external antenna connecting cable for mobile use with standard car antennas. And there's a write-on log panel to record most-used frequencies. Dual Band Model 6252A price is $59.95 and you can write for further information to Channel Master, Ellenville, N.Y. 12428.

All Set for Cassette?

Those progressive folk, Ampex, have come up with a portable cassette tape player, the Tune Tripper, which they guarantee will give you a



Ampex Tune Tripper Portable Cassette

NOW...You can follow the footsteps of America's Astronauts on the moon...with the new, inflatable HAMMOND MOON GLOBE!

A Triumph Of Graphics, Cartography And Research...

NOW AVAILABLE IN BOTH STANDARD AND ILLUMINATED MODELS

This detailed new inflatable globe lets you pinpoint where Apollo 11 Astronauts Neil Armstrong and Buzz Aldrin first walked on the moon. Find the Sea of Tranquility...the Sea of Serenity...the Ocean of Sorrows...all the places whose names are soon to become bywords of the Space Age. Spot mountain ranges, waterless seas and craters. Find future Apollo mission landing sights. Use the latitudinal and longitudinal grid to locate every feature—every point that man explores.

APOLLO 11 ASTRONAUTS ARMSTRONG, COLLINS, AND ALDRIN

FOR YEARS A DREAM ...NOW A REALITY!

The inflatable Hammond Moon Globe is a generous 13 inches in diameter; constructed of tough, lifetime plastic; and most important, is expertly lithographed by Hammond's own world renowned craftsmen.

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YES! Please rush me #_____Hammond Moon Globe(s) today!
I enclose my check (or money order) for $_____ to cover:
#_____Illuminated Model(s) @ only $16.95 ea.
#_____Standard Model(s) @ only $12.50 ea.
PLUS 75¢ EACH FOR POSTAGE AND HANDLING

NAME_____

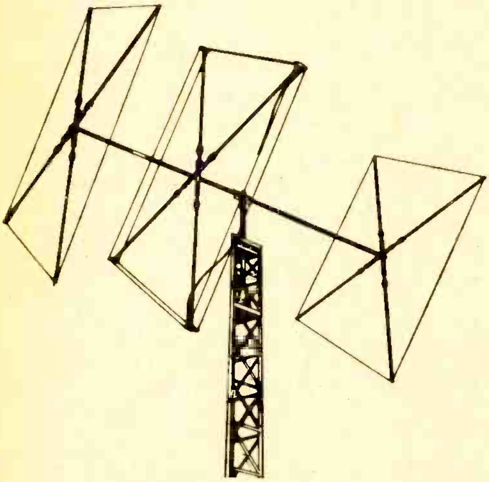
ADDRESS_____

CITY_____STATE_____ZIP_____

good trip. Tune Tripper, or AST-1, is monaural, powered by six batteries, measures 6 x 2½ x 10 in., and weighs 2½ lb. with batteries. You can feed the Tune Tripper with any of Ampex Stereo Tapes' more than 6000 selections. The price is $29.88 and the source is Ampex Corp., 2201 Estes Ave., Elk Grove Village, Ill. 60007.

Join the Mod Squad

Here's a new Mosley CB cubical quad with polarization which they're calling the Mod Quad (Model MCQ-27VH). The switching system includes a double radiator element, two gamma matches, and a polarization control box which permits polarization change at the flip of a switch from within the base station. The Mod Quad has three widely spaced elements on 14-ft. boom for top gain. High directivity eliminates unwanted side and back signals and low radiation angle keeps the signal close to the ground for maximum distance. Construction is of copper-coated steel wire, heavy-duty aluminum tubing, molded high-impact insulators, and stainless steel hardware. Feed point impedance is 52 ohms nominal, and the unit has forward gain of 9 dB compared to reference dipole, 11.1 over isotropic source. The Mod Quad withstands a wind load of 151 lbs. and weighs about 40 lbs. Price is $122.05 and you can get more specs from Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.



Mosley Mod Quad MCQ-27VH

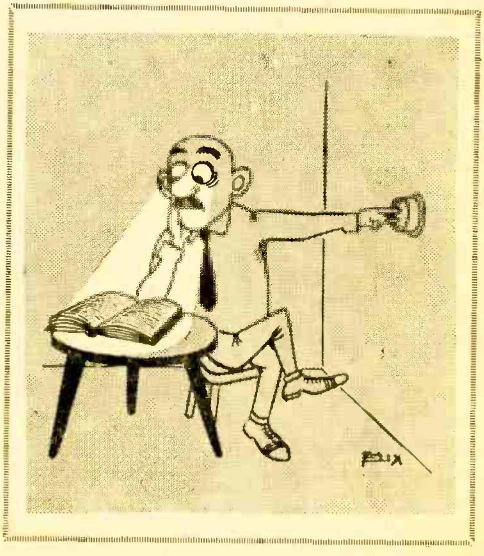
By Jupiter! Via Telescope

Now that all the world is an astronomer, wouldn't it be wonderful to have your own backyard telescope? Can't afford it? Edmund Scientific have put on the market a 6-in. mirror telescope optics kit (stock No. 71,191) for $75.00 which would cost about $250.00 already assembled. The mirror itself is already ground and polished, aluminized and overcoated, and there's a ⅜-in. thick elliptical diagonal with 1¾-in. major axis and 1¼-in. minor, a 28 mm focal length Kellner eyepiece with 50° field of view and standard 1¼-in. barrel diameter and 2 achromats mounted in black anodized aluminum. The kit comes with a 36-page book, "Telescopes You Can Build," as well as specific instructions. The 6-in. reflector telescope will pick up four times as much light as a 3-in. scope, enabling you to view stars up to the 13th magnitude and resolve star clusters. To order by mail, or for more details write Edmund Scientific Co., Edscorp Bldg., Barrington, N.J. 08007.

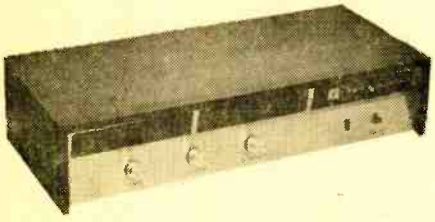
Edmund 6-In. Mirror Telescope Optics Kit

Reverrrrrb!

You can convert your sound system, stereo or monaural, to full-dimension reverberated sound with this new Gibbs Reverberator. Featuring a 10-watt amplifier specifically designed for reverberation, the unit uses solid-state components. Distortion is less than 3% at 1000 Hz, and both input and output impedance is 8 ohms. There are terminals on the rear panel for stereo or monaural amplifier leads and an auxiliary



speaker. Controls on the front panel permit full tone control and the amount of reverberation desired. You can also run the music source without turning on the reverberation unit or

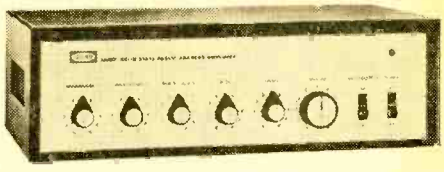


Gibbs Reverberator

disconnecting any amplifier or speaker leads. Price is $70.00 and further information may be obtained by writing to Gibbs Special Products Corp., 450 N. Main St., Janesville, Wis. 53545.

Now Hear This! PA Amp!

The new Allied 45-watt public address amplifier, model 3246T will power sound columns, outdoor weatherproof trumpets, indoor baffled speakers, or may be packed into a speaker case for portable use. It features a silicon-transistor circuit, inverse feedback, sound reproduction for paging, voice, or music distribution. The 3246T has microphone precedence—permitting paging over a program in progress. Rear of chassis has an AC outlet, and a low-frequency filter may be switched in to cut feedback and protect speakers from overload. Mike inputs are switch-controlled for low or high impedance. There are two auxiliary inputs to connect a phonograph, tuner or tape recorder. It can be used in either constant-voltage or standard im-



Allied 3246T Public Address Amplifier

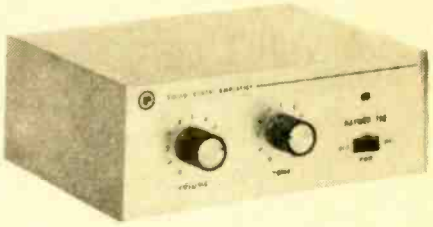
pedance installations. Other features: separate calibrated bass and treble controls, gain controls for mike and auxiliary inputs and extra large master gain control. Frequency response is 40-10,000 Hz. The 3246T amplifier is priced at $79.95 and you can get an optional top-mounting 4-speed turntable for $24.95. Write Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680 for info. *(turn page)*

HEY, LOOK ME OVER . . . ★★★★★★★★

Continued

Neat Li'l Amp

We have here model 790 from Trutone Electronics, an all-silicon solid-state audio amplifier with a sine wave output of 6 watts. Can be used at home, in offices, schools—anywhere you want microphone paging or music. The amplifier is supplied with one input for high-impedance microphone or music; speaker output



Trutone Raymer 790 Amplifier

is 8 ohms, 25-V line, 70-V line. Housed in a tan metal cabinet measuring 7 x 6⅛ x 3⅛ in., the unit is said to have foolproof operation. Should the output of the amplifier be shorted, mismatched, or have no load no harm will come to the transistors. Carrying a warranty of one year, the 790 is priced at $61.50. For further information write to Trutone Electronics, Inc., 14660 Raymer St., Van Nuys, Calif. 91405.

Swing from SWL to BCB

Mosley Electronics' TRS-57 transformer-balun for SWL antennas has been developed to adapt their SWL-7 and RD-5 shortwave listening antennas to receive standard broadcast bands below 4 MHz. The transformer-balun automatically transforms the doublet into the long wire antenna necessary for broadcast

(Continued on page 99)

"They say our signal is fading!"

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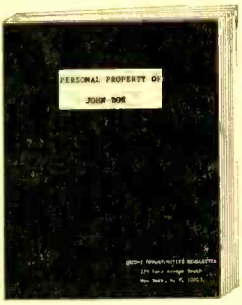

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LITERATURE

ELECTRONIC PARTS

★2. Now, get the all-new 512-page, fully illustrated *Lafayette Radio* 1969 catalog. Discover the latest in CB gear, test equipment, ham gear, tools, books, hi-fi components and gifts. Do it now!

★5. *Edmund Scientific's* new catalog contains over 4000 products that embrace many interests and fields. It's a 148-page buyers' guide for Science Fair fans.

4. *Olson's* catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names. Don't believe us? Get a copy.

★1. *Allied's* catalog is so widely used as a reference book that it's regarded as a standard by people in the electronics industry. Don't *you* have the 1969 *Allied Radio* catalog? The surprising thing is that it's free!

7. Before you build from scratch, check the *Fair Radio Sales* latest catalog for electronic gear that can be modified to your needs. *Fair* way to save cash.

8. Get it now! *John Meshna, Jr.'s* new 96-page catalog is jam packed with surplus buys—surplus radios, new parts, computer parts, etc.

140. How cheap is cheap? Well, take a gander at *Cornell Electronics'* latest catalog. It's packed with bargains like 6W4, 12AX7, 5U4, etc., tubes for only 33¢. You've got to see this one to believe it!

★135. Get with ICs! *RCA's* new integrated Circuit Experimenter's Kit KD2112 is the first of its kind and should be a part of your next project. Get all the facts direct from *RCA*. Circle 135.

106. With 70 million TV and 240 million radios somebody somewhere will need a vacuum tube replacement at the rate of one a second! Get *Universal Tube Co.'s* Troubleshooting Chart and facts on their $1.50 flat rate per tube.

10. *Burstein-Applebee* offers a new giant catalog containing 100s of big pages crammed with savings including hundreds of bargains on hi-fi kits, power tools, tubes, and parts.

11. Now available from *EDI (Electronic Distributors, Inc.)*: a catalog containing hundreds of electronic items. *EDI* will be happy to place you on their mailing list.

6. Bargains galore, that's what's in store! *Poly-Paks Co.* will send you their latest 8-page flyer chock-full of *Poly-Paks'* new $1.00 electronic and scientific "blis-dor" paks and equipment.

23. No electronics bargain hunter should be caught without the 1969 copy of *Radio Shack's* catalog. Some equipment and kit offers are so low, they look like misprints. Buying is believing.

CB--AMATEUR RADIO SHORTWAVE RADIO

102. No never mind what brand your CB set is. *Sentry* has the crystal you need. Same goes for ham rigs. Seeing is believing, so get *Sentry's* catalog today. Circle 102.

146. It may be the *first*—*Gilfer's* speciality catalog catering to the SWL. Books, rigs, what-nots—everything you need for your listening post. Go *Gilfer*, circle 146!

100. You can get increased CB range and clarity using the "Cobra-23" transceiver with speech compressor—receiver sensitivity is excellent. Catalog sheet will be mailed by *B&K Division of Dynascan Corporation.*

141. Newly-designed CB antenna catalog by *Antenna Specialists* has been sectionalized to facilitate the picking of an antenna or accessory from a handy index system. Man, *Antenna Specialists* makes the pickin' easy.

130. Bone up on the CB with the latest *Sams* books. Titles range from "ABC's of CB Radio" to "99 Ways to Improve your CB Radio." So Circle 130 and get the facts from *Sams*.

107. Want a deluxe CB base station? Then get the specs on *Tram's* all new Titan II—it's the SSB/AM rig you've been waiting for!

96. Get your copy of *E. F. Johnson's* new booklet, "Can *Johnson* 2-Way Radio Help Me?" Aimed for business use, the booklet is useful to everyone.

129. Boy, oh boy—if you want to read about a flock of CB winners, get your hands on *Lafayette's* new 1969 catalog. *Lafayette* has CB sets for all pocketbooks.

46. Pick up *Hallicrafters'* new four-page illustrated brochure describing Hallicrafters' line of monitor receivers —police, fire, ambulance, emergency, weather, business radio, all yours at the flip of a dial.

116. Pep-up your CB rig's performance with *Turner's* M+2 mobile microphone. Get complete spec sheets and data on other *Turner* mikes.

48. *Hy-Gain's* new CB antenna catalog is packed full of useful information and product data that every CBer should know. Get a copy.

111. Get the scoop on *Versa-Tronics'* Versa-Tenna with instant magnetic mounting. Antenna models available for CBers, hams and mobile units from 27 MHz to 1000 MHz.

45. CBers, Hams, SWLs—get your copy of *World Radio Labs'* 1969 catalog. If you're a wireless nut or experimenter, you'll take to this catalog.

101. If it's a CB product, chances are *International Crystal* has it listed in their colorful catalog. Whether kit or wired, accessory or test gear, this CB-oriented company can be relied on to fill the bill.

103. *Squires-Sanders* would like you to know about their CB transceivers, the "23'er" and the new "S5S." Also, CB accessories that add versatility to their 5-watters.

TOOLS

★78. *Xcelite's* midget hex socket screwdrivers in *Xcelite's* PS-89 set let you make delicate adjustments easier. "Piggyback" handle adds grip, reach, and power needed for other jobs.

118. Secure coax cables, speaker wires, phone wires, etc., with *Arrow* staple gun tackers. 3 models for wires and cables from 3/16" to 1/2" dia. Get fact-full Arrow literature.

ELECTRONIC PRODUCTS

143. Bring new life to your hobby. Exciting plans for new projects—let Electronics Hobby Shop give you the dope. Circle 143, now.

44. Kit builder? Like wired products? *EICO's* 1969 catalog takes care of both breeds of buyers. 32 pages full of hi-fi, test, CB, ham, SWL, automotive and hobby kits and products —do you have a copy?

★42. Here's colorful 116 page catalog containing a wide assortment of electronic kits. You'll find something for any interest, any budget. And *Heath Co.* will happily send you a copy.

144. Hear today the organ with the "Sound-of-Tomorrow," the Melo-Sonic by *Whippany Electronics*. It's portable—take it anywhere. Send for pics and descriptive literature.

12. *C. B. Hanson* new Automatic Control records both sides of a telephone call automatically—turns off automatically, too! Get all the details —today!

126. Did you dig *Delta's* new literature package chucked full of pics and

LIBRARY

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specs on such goodies as an FET-VOM, SCR ignition system, computerized auto tach, hi-voltage analyzer, etc.? Man, then let *Delta* know you're alive! Circle 126 now!

109. *Seco* offers a line of specialized and standard test equipment that's ideal for the home experimenter and pro. Get specs and prices today.

9. Troubleshooting without test gear? Get with it—let Accurate Instrument clue you in on some great buys. Why do without?

145. *Alco Electronic Products* has 28 circuit ideas using their remote control relay. Get 100-and-one odd jobs done at home without calling an electrician. Get all the facts today!

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★136. You can become an electrical engineer *only* if you take the first step. Circle 136 and *ICS* will send you their free illustrated catalog describing 17 special programs. *ICS* also has practical electrical courses that'll increase your income.

★74. Get two free books—"How to Get a Commercial FCC License" and "How to Succeed in Electronics"—from *Cleveland Institute of Electronics.* Begin your future today!

★3. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools and instructions come with course.

142. *Radio-Television Training of America* prepares you for a career—not a job. 16 big kits help you learn as you build. 120 lessons. Get all the facts today!

114. Prepare for tomorrow by studying at home with *Technical Training International.* Get the facts today on how you can step up in your present job.

★137. For success in communications, broadcasting and electronics get your First Class FCC license and *Grantham School of Electronics* will show you how. Interesting booklets are yours for the asking.

HI-FI/AUDIO

104. You can't hear FM stereo unless your FM antenna can pull 'em in. Learn more and discover what's available from *Finco's* 6-pages "Third Dimensional Sound."

119. *Kenwood* puts it right on the line. The all-new *Kenwood* FM-stereo receivers are described in a colorful booklet complete with easy-to-read-and-compare spec data. Get your copy today!

30. *Shure's* business is hi-fi — cartridges, tone arms, and headphone amps. Make it your business to know *Shure!*

17. Mikes, speakers, amps, receivers—you name it, *Electro-Voice* makes it and makes it good. Get the straight poop from *E-V* today.

99. Get the inside info on why *Koss/Acoustech's* solid-state amplifiers are the rage of the experts. Colorful brochure answers all your questions.

26. The all new, lavishly-illustrated, full-color brochure, "At Home With Stereo" clues you in on *H.H. Scott's* 1969 stereo consoles. Discover how to pick a hi-fi console for your living room.

TAPE RECORDERS AND TAPE

14. You just gotta get *Craig's* new pocket-size, full-color folder illustrating what's new in home tape recorders—reel-to-reel, cartridge and cassette, you name it! It looks like a who's who for the tape industry.

123. Yours for the asking—*Elpa's* new "The Tape Recording Omnibook." 16 jam-packed pages on facts and tips you should know about before you buy a tape recorder.

31. All the facts about *Concord Electronics Corp.* tape recorders are yours for the asking in their free 1970 catalog. Portable, battery operated to four-track, fully transistorized stereos cover every recording need.

34. "All the Best from *Sony*" is an 8-page booklet describing *Sony-Superscope* products—tape recorders, microphones, tape and accessories. Get a copy today before you buy!

35. If you are a serious tape audiophile, you will be interested in the all new *Viking/Telex* line of quality tape recorders.

TELEVISION

70. Need a new TV set? Then assemble a *Heath* TV kit. *Heath* has all sizes. B&W and color, portable and fixed. Why not build the next TV you watch?

127. *National Schools* will help you learn all about color TV as you assemble their 25-in. color TV kit. Just one of *National's* many exciting and rewarding courses.

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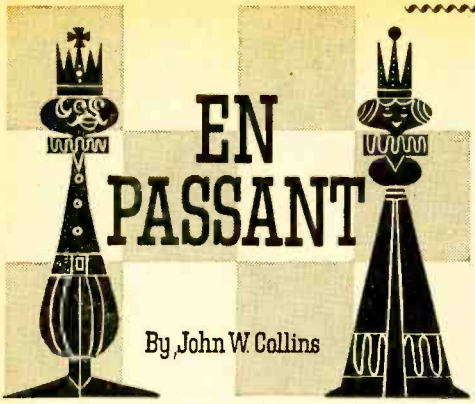
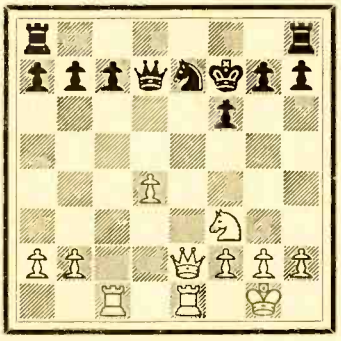


Grandmaster Samuel Reshevsky, five times Champion of the United States, once wrote: "It is essential for the beginner and the average player to acquire a basic knowledge of the openings. In my opinion, it is unwise for such players to attempt to master all the openings; instead, they should concentrate on a few and learn them thoroughly." This is good practical advice for the player who does not have time or material to study, and for the one who has difficulty in understanding and remembering. But the ideal is to know at least a little something about all of the debuts. An idea gleaned from the study of one never actually employed can frequently be incorporated into one played every day. Limitation can be self-defeating.

Giuoco Piano. The Giuoco Piano (Quiet Game) may be the oldest recorded opening which dates back to 1490! Except for Mednis and Rossolimo, American masters consider it too drawish, Black usually being able to enforce. . . . P-Q4 and to catch up in development. But the Giuoco is many-sided and can range from the dull to the wild. This is the classical variation of it:

1 P-K4	P-K4	3 B-B4	B-B4
2 N-KB3	N-QB3	4 P-B3	N-B3!

Black



White

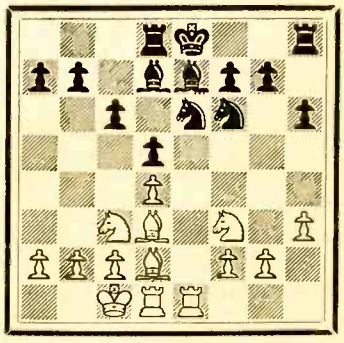
5 P-Q4	PxP	11 NxN	BxN
6 PxP	B-N5#	12 KBxB	QxB
7 N-B3	P-Q4	13 BxB	NxB
8 PxP	KNxP	14 R-K1	P-KB3!
9 0-0	B-K3	15 Q-K2	Q-Q2
10 B-KN5	B-K2	16 QR-B1	K-B2!

White is ahead in development and controls more space, but Black has the sounder pawn-formation. The over-all chances are even.

Petrov Defense. This bears the name of A. D. Petrov, a Russian of the last century. It is an immediate counter-attack against the King's Pawn, semi-open, initially full of traps, and quite sound, but rather short on strategic conceptions. Here is Lasker's Variation, marked by an early exchange of Queens:

1 P-K4	P-K4	9 N-B3	P-B3
2 N-KB3	N-KB3	10 0-0-0	N-R3
3 NxP	P-Q3	11 KR-K1	N-B2
4 N-KB3	NxP	12 B-B1	N-K3
5 Q-K2	Q-K2	13 B-Q2	B-Q2
6 PQ3	N-KB3	14 P-Q4	P-KR3
7 B-N5	QxQ#	15 B-Q3	P-Q4
8 BxQ	B-K2	16 P-KR3	R-Q1

Black



White

With Queens off and a symmetrical position, there are no real winning chances for either side.

Colle System. Edgar Colle, a Belgian master, invented this one and scored many brilliant victories with it. It is a slow starter, and it shuts in the Queen Bishop, but it often erupts dangerously. The King's Fianchetto Defense is a very logical response:

1 P-Q4	P-Q4	8 P-QN4!	PxNP
2 N-KB3	N-KB3	9 PxP	N-K1
3 P-K3	P-B4	10 B-N2	N-Q3
4 QN-Q2	QN-Q2	11 Q-N3	N-N3
5 P-B3	P-KN3!	12 P-QR4	B-B4!
6 B-Q3	B-N2	13 BxB	PxB
7 0-0	0-0	14 P-N5	QN-B5

(Diagram on page 30)

Equal chances.

(Continued on page 30)

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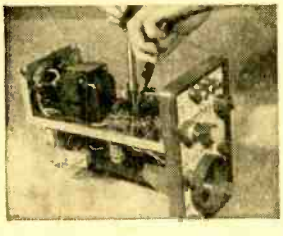
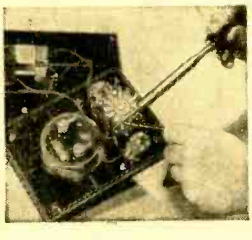
Construction of Oscilloscope.



Construction of Multimeter.



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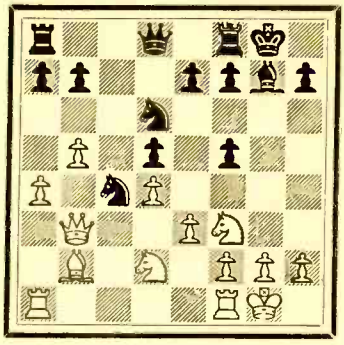
Colle System. Text on page 26.

Black

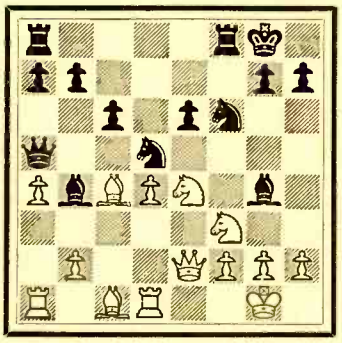


White

Slav Defense. The Slav Defense is the largest branch on the Queen's Gambit tree. A favorite of former World Champions Euwe and Smyslov, it is also suitable for beginners and average players because it affords easy development, good piece play, and a promising ending. The Dutch Variation brings out its main features:

1	P-Q4	P-Q4	8 O-0	O-0
2	P-QB4	P-QB3	9 Q-K2	QN-Q2
3	N-KB3	N-B3	10 P-K4	B-N5!
4	N-B3	PxP	11 R-Q1	Q-R4
5	P-QR4	B-B4	12 P-K5	N-Q4
6	P-K3	P-K3	13 N-K4	P-B3
7	BxP	B-QN5	14 PxP	N/2xP

Black



White

A big, sprawling position, not readily evaluated. Each side is well developed and has an isolated Pawn.

Game of the Issue. Boris Vasilyevich Spassky is the new Chess Champion of the World. Spassky was born on Jan. 30, 1937, in Leningrad, learned the game at a very early age and was playing tournaments when 10. At 16, he became an International Master, at 18, World Junior Champion, in 1966, he lost the title match to Petrosian by 11½-12½, but in the same year he won the Second Piatigorsky International Cup at Santa Monica, Calif., finishing ahead of Fischer and Reshevsky. In the Interzonal Tournament at Sousse, Tunisia, 1967, he wound up in the top eight and thereby qualified for the Challenger Matches. In these he successively defeated Geller, Larsen, and Korchnoi, and thus earned the right to play Petrosian for the title.

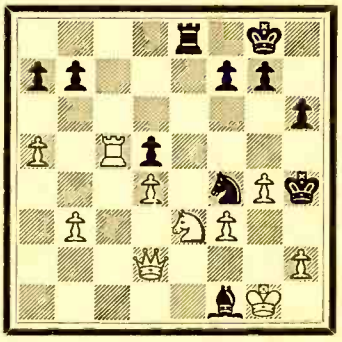
The final result of the championship match was Spassky 12½, Petrosian 10½, the decisive draw in game No. 23 occurring on the loser's 40th birthday. Play in the match was of a high order, though often marked by mistakes, and the number of wins was unusual for a championship match.

Spassky resides in Moscow (the site of the match), is married and has a two year-old son, has a degree in journalism, earns his living by chess, and is the editor of "64," a weekly chess magazine.

In the following game, the 4th of the match, Spassky (Black) essays the old, controversial, Tarrasch Defense, obtains the more comfortable position, "maneuvers precisely," "attacks effectively," and wins his first game.

1	P-QB4	P-K3	22	B-R3	R-B5
2	P-Q4	P-Q4	23	P-KN4	R-N5!
3	N-QB3	P-QB4	24	P-N3	N-B3
4	PxQP	KPxP	25	Q-Q2	R-N3
5	N-B3	N-QB3	26	N/3-K2	B-R2
6	P-KN3	N-B3	27	B-N2	R-K1
7	B-N2	B-K2	28	N-N3	NxN
8	O-O	O-O	29	PxN	R-K3
9	B-N5	PxP	30	RxR	QxR
10	KNxP	P-KR3	31	R-QB1	B-N3
11	B-K3	B-KN5	32	B-B1	N-R2
12	N-N3	B-K3	33	Q-B4	N-B1
13	R-B1	R-K1	34	R-B5	B-N8
14	R-K1?	Q-B2	35	P-QR4	N-N3
15	B-B5	QR-B1	36	Q-Q2	Q-KB3
16	BxB	QxB	37	K-B2	N-B5!
17	P-K3	KR-Q1	38	P-R5?	B-Q6!
18	Q-K2	B-N5	39	N-B5	Q-N4!
19	P-B3?	B-B4	40	N-K3	Q-R5#
20	QR-Q1	N-K4	41	K-N1	BxB
21	N-Q4	B-N3		Resigns	

Position after 41 . . . BxB



Why did White resign? Because he will be mated, lose his Queen for a Rook or a Knight,

(Continued on page 101)

ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

Orbit

▲ After the chariot became the chief military vehicle, the *orbis* or wheel gained new importance. A wheel-track, known to Romans as an *orbit* and produced by repeatedly driving over the same course on parade grounds and in amphitheaters such as the Circus Maximus, was roughly circular.

Once it became apparent to astronomers that planets revolve around the sun, the resemblance between such a path of revolution and a wheel-track was obvious. In the 5th edition of his then-famous "New World of English Words" (1696), Edward Phillips explained that an *"orbit is properly the Tract left by a Wheel in the Road; but Astronomers use the word to signifie the way or course of the Sun, particularly called the Ecliptick, and also of any other Planet moving on according to the Circle of its Latitude."*

Proper or not, the word stuck in the vocabulary of astronomy. Once firmly established as a general term for an approximately circular pattern of revolution, the ancient term proved just right for use by modern physicists.

Strangely, even the 1961 edition of the famous 13-volume "Oxford English Dictionary" doesn't recognize the word in its application to an electron spinning about the nucleus of an atom. In spite of this scholarly snub, *orbit* has become the universal label for the path in which an electron—or a spaceship—revolves. Growing capacity to move electrons from their normal "chariot tracks" into other orbits is basic to many phases of atomic science.

Nickel

▲ Axel F. von Cronsted seldom rates even a short paragraph in an encyclopedia. To his contemporaries, the Swedish seeker after nature's secrets seemed a harmless but uninspired plodder. They considered his life-absorbing interest in mineralogy sure proof that he didn't know where to focus his energy in order to make major discoveries.

Cronsted even wasted a lot of time and energy on *kupfernickel*. Everyone (except Cronsted) knew that this common ore is worthless. Though copperlike in appearance, it yields none of the highly-prized metal. Hence the German name of the ore—roughly equivalent to "the copper-colored stuff made by a mischievous demon."

In spite of repeated failures, Cronsted continued to press his efforts to extract a metal from kupfernickel. He finally succeeded in 1751. But the impure stuff he obtained wasn't remotely like copper. Hard and silvery-white, it had no known use. So it wasn't until 1754 that Cronsted got around to abbreviating the name of the ore from which he got it and calling the new metal *nickel*.

Strongly ferromagnetic, the lustrous metal eventually entered wide use as a plating material. Once an abundant supply became available, new research showed that it could be useful in production of magnetic alloys.

Today the substance that folk-lore linked with pranks of a demon helps electronic equipment to perform technological wonders.

Static

▲ Until complex equipment was produced to make the job easy, it required considerable skill to weigh things accurately. Latin *staticus* indicated a state in which the needle of a balance ceased to waver. From this usage, *static* entered 17th-century English to name any state or act linked with the process of weighing.

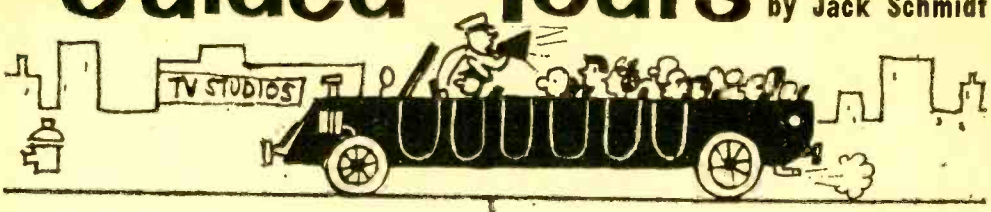
Influenced by the fact that many disciplines have names that end in *-ics* (mechanics, for example) an "s" was tacked on the word that designated the science of weights. Statics in time came to be concerned largely with action of forces producing equilibrium. In this sense, it was the opposite of "dynamics."

With the advent of the wireless telegraph it was found that relative equilibrium in the atmosphere fosters transmission of messages. But pioners in the study of "atmospheric stability" found the title too long and clumsy, so dropped it in favor of the familiar "statics."

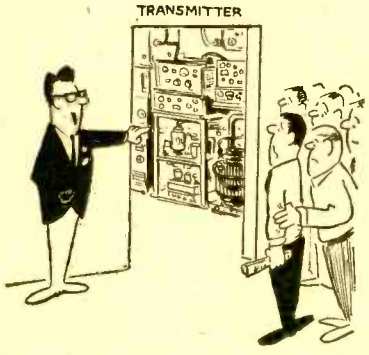
As knowledge accumulated, it became clear that even when conditions seem to be stable, components in a field of statics are likely to produce interference. Dropping the terminal "s" that had been added 250 years earlier, wireless operators adopted *static* as a label for noise produced by atmospheric forces outside a man-made system. It wasn't until 1918, however, that "Webster's New International Dictionary" included in the addenda a reference to the special kind of interference that affects electrical communications systems.

As a result of linguistic turns and twists, a self-contradictory label is now in universal use. Every amateur knows that static stems from operation of dynamic forces, rather than from those in a system as motionless as a balance whose needle has stopped quivering. ■

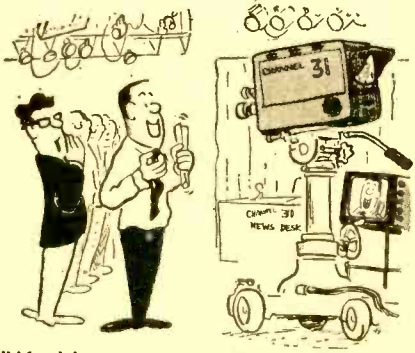
Guided Tours by Jack Schmidt



"... even in this age of automation our engineers monitor all technical functions ..."

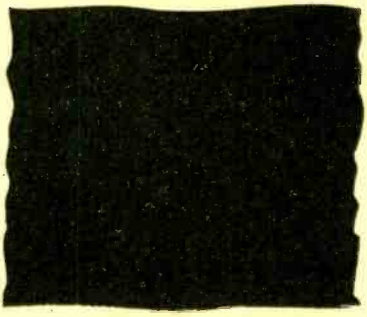


"This whole room is full of hot tubes, so we'll just look in the door briefly on our way to the Makeup Department!"

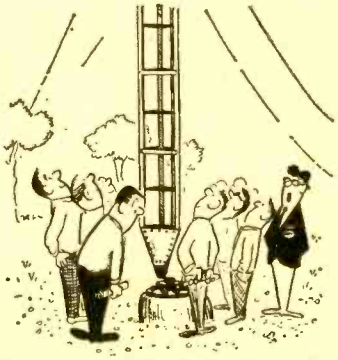


"Would you move on, Sir ... others in the group would like to see themselves on TV"

"... a market area penetration of 70.067% with 38.065% response on a selected analysis ..."



"... and in here we develop our own film!"



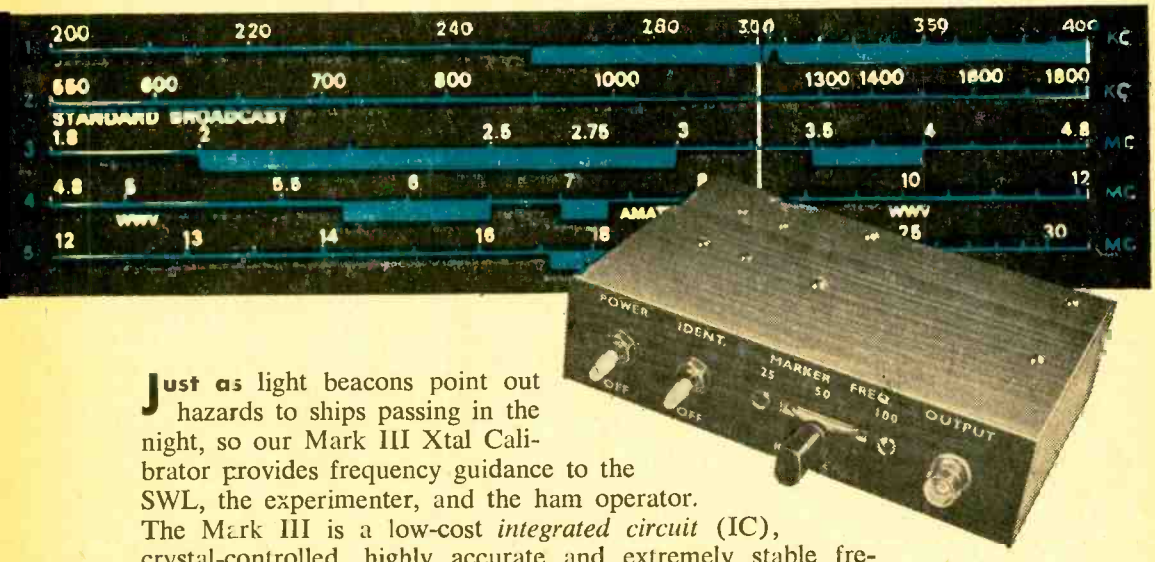
"... the tower weighs 247 tons, is 1132 feet high, the top sways 2½ inches in a 60 mph wind ..."

elementary Electronics NOV-DEC 1969

MARK III XTAL CALIBRATOR

You can be sure of the frequency when calibrating your receiver or locating new sub-band edges when transmitting. This compact, battery powered calibrator uses state-of-the-art ICs and crystal standard for accuracy, stability, and marker signals not found in commercially built units.

by Ed Morris, W2VLU



Just as light beacons point out hazards to ships passing in the night, so our Mark III Xtal Calibrator provides frequency guidance to the SWL, the experimenter, and the ham operator. The Mark III is a low-cost *integrated circuit* (IC), crystal-controlled, highly accurate and extremely stable frequency calibrator. It provides easily identified marker pulses at 25, 50, 100 kHz, and, in fact, all the way to 200 MHz and beyond.

It helps the SWL pinpoint the frequency of the signal he is tuned to and also makes it easier to spot and identify rare DX stations. Ham operators will appreciate the benefits of the 25- and 50-kHz markers in identifying the new sub-brand edges, which are not exact multiples of 100 kHz.

A feature not found in any of the commercial calibrators currently avail-

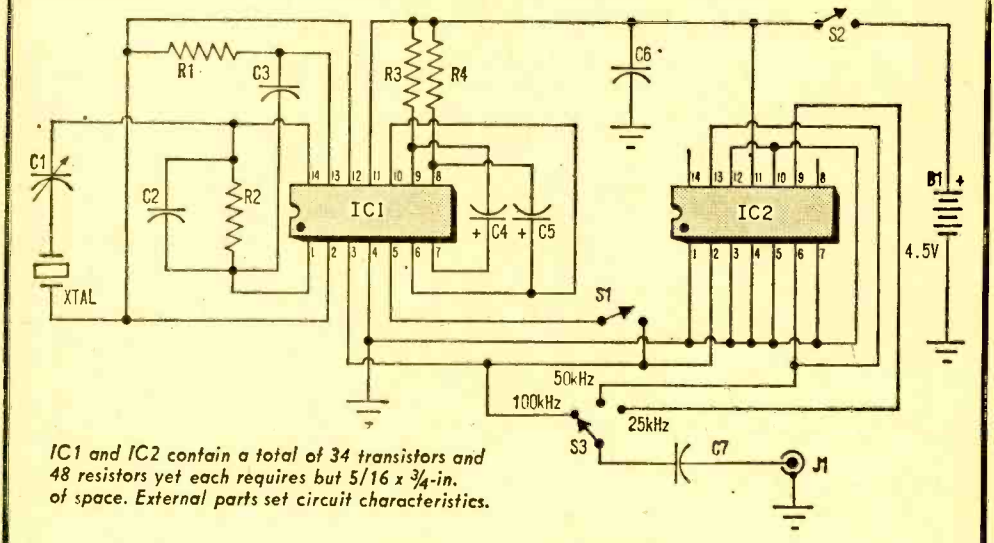
able is the unique type of identification produced by the Mark III. The output marker signals can be pulsed *on* and *off* twice a second. This is a great aid in separating the markers when the band is full of QRM and unmodulated carriers.

Ease of construction and wiring as well as low component cost are achieved by using two plastic ICs that can be bought for $3.35 the pair. These two ICs replace a total of 34 transistors and 48 resistors.

Entire cost to build this calibrator, using all new parts, should be less than $23.00. **You can cut this figure almost in half if you** happen to own or can borrow a crystal of the type used in our unit.

Construction time to build the calibrator is between 3 to 5 hours, depending on the adeptness of the constructor. Our unit is housed in a 6 x 4½ x 1½-in. aluminum cabinet attractively covered with vinyl plastic sheet which can be selected to blend with the decor of the room the calibrator will be used in. Even though this won't affect its operating characteristics it will improve family relations where the living room is also your base of operations.

It's The ICs. Mark III works in a straightforward manner. Circuit IC1 is a hex inverter. The inverters on this IC chip generate,

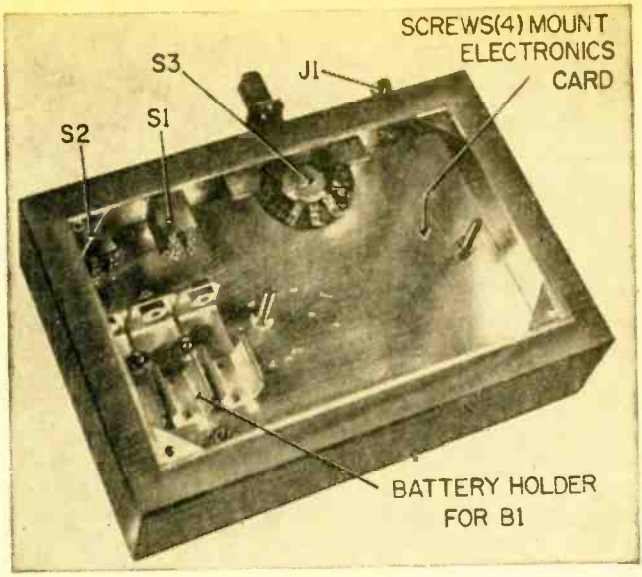


IC1 and IC2 contain a total of 34 transistors and 48 resistors yet each requires but 5/16 x ¾-in. of space. External parts set circuit characteristics.

PARTS LIST FOR MARK III CALIBRATOR

B1—4.5-V battery consisting of 3 AA mercury cells (Lafayette 32T4685 or equiv.)
C1—7-45 pF ceramic trimmer capacitor (Lafayette 32T2511 or equiv.)
C2—100-pF, 1000-VDC disc ceramic capacitor (Lafayette 33T2284 or equiv.)
C3—5000-pF, 1000-VDC disc ceramic capacitor (Lafayette 33T2331 or equiv.)
C4, C5—50-uF, 12-VDC miniature electrolytic capacitor (Lafayette 99T6085 or equiv.)
C6, C7—0.01-uF, 75-VDC disc ceramic capacitor (Lafayette 33T6905 or equiv.)
IC1—Integrated circuit Hex Inverter (Motorola MC-789P)
IC2—Integrated circuit Dual JK Flip-Flop (Motorola MC-790P)
J1—BNC output connector, single hole mounting, type UG652 B/U (Lafayette 32T2121 or equiv.)
S1, S2—Dpdt toggle switch (Lafayette 99T-6162 or equiv.) Note: only one pole used
S3—Miniature lever switch, 3 position, 2 circuit, non-shorting, positive action (Lafayette 30T4151 or equiv.)
Xtal 1—100-kHz parallel resonant crystal type S6P13 (available from Sentry Mfg. Co., Crystal Park, Chickasha, Okla. 73018 at $9.00, shipped prepaid air mail within continental United States within 24 hours after receipt of order)
1—Aluminum chassis, 6 x 4 x 1½-in. (Lafayette 12T8190 or equiv.)
1—Bottom plate for above chassis (Lafayette 12T8287 or equiv.)
1—Crystal socket Sentry type D40-152 (available from Sentry at 15¢ each—see address above)
1—2¼ x 3¼-in. piece epoxy glass sheet

Misc.—Vinyl covering (Contact or equiv.), miniature eyelets, wire, solder, nuts, bolts, etc.



Bottom view during initial assembly showing location for electronics card sub-assembly and battery holder, also controls on front panel. Keep circuit card away from chassis.

shape, and amplify a 100-kHz square wave and provide the marker pulses. Circuit IC2 is a dual J-K flip-flop, dividing the 100-kHz signal to 50 kHz, and that, in turn, to 25 kHz.

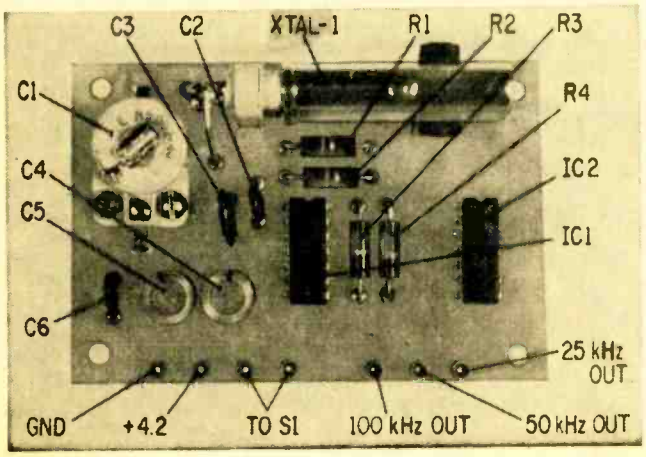
To be more explicit, IC1 contains six individual circuits, each of which is equivalent to a transistor amplifier that provides the simple inversion function. Two of these inverters are biased for class-A operation by R1 and R2. Capacitor C3 controls the output of the first one to the input of the second. Positive feedback is obtained by connecting the output of the second inverter to the input of the first through the crystal and trimmer capacitor C1. The output is a 100-kHz square wave. Because a parallel resonant crystal is sensitive to variations in load capacitance, the crystal can be trimmed to exactly 100 kHz by the trimmer capacitor.

A third inverter shapes the 100-kHz square wave and acts as a buffer to prevent variations in load from reflecting back into the oscillator, which would affect the oscillator frequency.

This buffered signal is fed to the first J-K flip-flop in IC2, which is connected as a divide-by-two counter, thus dividing the output to a 50-kHz square wave. This 50-kHz square wave, in turn, is divided in two by the second flip-flop in IC2 to produce the 25-kHz square wave markers. Switch S3 selects either the 100 kHz, the 50 kHz, or the 25 kHz output and couples the selected signal to jack J1 through capacitor C7. This capacitor also serves to block the DC component of the output signal.

The identification pulse function is achieved by connecting two of the remaining inverters in IC1 to form an astable multivibrator. The time constants of resistors R3 and R4 in conjunction with capacitors C4 and C5 establish the frequency of the multivibrators at 2 Hz. This very low frequency square wave is coupled to the input of the sixth inverter in IC1, which serves as a buffer. Switch S1 is used to couple the 2-Hz square wave pulse to the output of the 100-kHz generator, keying the output *on* and *off*. Since the 25- and 50-kHz outputs are derived by dividing the 100-kHz output, they too are keyed at the 2-Hz rate whenever S1 is closed.

Let's Make One. We used a 6 x 4½ x 1½-in. aluminum chassis and matching bottom plate to house our Mark III. You may prefer a different

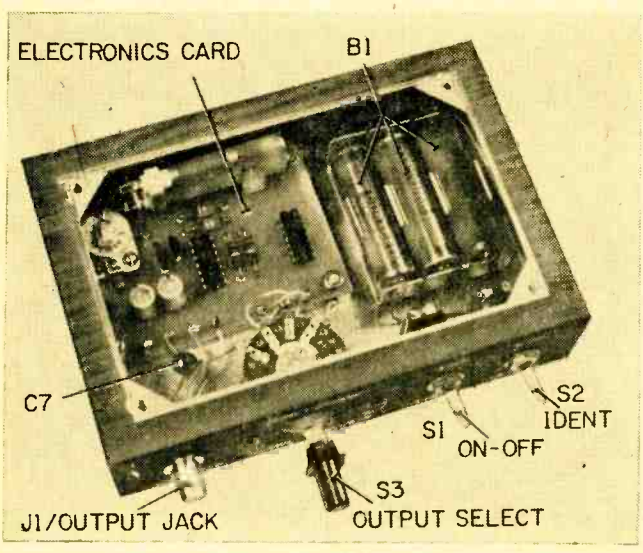


Electronics circuit card made from epoxy glass sheet holds all components except controls and battery. Note location of notch on ICs before soldering into place.

housing, or may want to combine it into an existing piece of test equipment, or build it into your receiver.

Scribe all the holes to be drilled in the housing and center punch them so that drilling will be accurate. A T-square will help in the layout work, particularly in laying out the slot for lever switch S3. After scribing the slot outline, drill a series of 3/32-in. holes within the outline as close together as possible. File the separations between holes with a needle file and dress the opening to the scribed outline. De-burr all of the holes and wash off the outer surfaces to ensure that all dirt and oil have been removed. Unless this is done the pressure-sensitive adhesive backing of the vinyl sheeting used to finish the housing may not stick tightly.

Front panel view of the Mark III details in-line arrangement for all controls. Use transfer or Datak letters for control identification to give your unit the professional appearance.



Bottom view of completed calibrator showing electronics card and batteries installed. Now use Mark III for numerous frequency checks

You'll need about one square foot of the vinyl material. When covering the chassis place the material on a smooth flat surface with the adhesive facing up. Center the chassis on the material and, after removing the protective cover from the adhesive, press the housing down firmly. Turn the housing over on its base and smooth out air pockets. Then fold the remaining material down over the sides, making slits at the corners for a neat, smooth finish all around. Some of the excess material may be folded over the edges and pressed down on the bottom. Use a razor blade or X-acto knife to remove vinyl from the holes and cutout in the housing.

To give the unit a professional look use dry transfer letters or decals to designate the function of the controls and output jack. Spray the finished lettered housing with several very light coats of clear acrylic to protect the lettering from abrasion.

Electronics Assembly. Except for the controls and the batteries, all of the components are mounted on a 2¼ x 3¼ x 1/16-in. piece of epoxy glass sheet. The layout isn't critical, though you may want to follow ours as shown in our photo. Be sure to keep all leads as short and direct as possible.

All holes for mounting and wiring components, except those for the two ICs, the trimmer capacitor, and the clip to hold the crystal, are eyeleted to anchor components and wiring. A 1/32-in. drill was used for the holes through which the pin connections from the ICs are passed. The pins are then folded back against the opposite side of the board. Pin numbers are read from the top of the IC. Starting from the identifying notch, with the notch to your left, and reading counterclockwise, pin 1 is the first pin of the bottom row.

Hooking It Up. We used #26 bare copper wire for all interconnections and formed it before soldering. This permits using a low-wattage soldering iron, keeping heat

(Continued on page 102)

HOW TO CONVERT YOUR DARKROOM TO COLOR

Tray develop your color prints in just 7 minutes

by James A. Gupton, Jr.

The attraction of color is an amazing phenomenon that has obsolesced everyday black-and-white. All objects are made more appealing by the proper application of color, and this is particularly true for photographs. Isn't it time you let electronics help you put a little color in your darkroom?

The basic reasons that cause many photographers to hesitate about making color prints are:

1. He feels that his equipment is not suitable for color work.
2. The cost of controls to maintain required limits in processing temperatures exceeds his equipment budget.
3. Color processing takes too much time compared to black-and-white.

These once were valid reasons. But now, the availability of Eastman Kodak's CP-5 Processing Kit makes processing color prints about as easy as turning out black-and-whites. Developed primarily for Kodak's Rapid Color Processors, the five-solution CP-5 processing kit can produce excellent color prints in your darkroom in just 7 minutes. Fig. 1 compares the process time and temperatures for black-and-white prints with CP-5 processed color prints. All calculations are based on Eastman Kodak's recommendations. Would you have believed that it takes more than double the time to make one black-and-white print than to make one color print?

The actual process and washing time for black-and-white prints requires four times that of color prints. Of course, these times are based on making a single print. In normal printing, we fudge a little by processing a number of prints at the same time, thus making the time seem even less.

Critical Temperature Control. The temperature range of chemicals for processing black-and-white prints should be 68°, ± 3°. Kodak recommends 65 to 75°F. Why, therefore, is it considered so critical to maintain the ± 2° required for color prints? The secret is to compensate for heat

loss with heat gain. To explain this further, how would chemicals heated to 100° lose their heat? The answer is by radiation and conduction to cooler room air.

If we can provide a constant source of 100° heat that is in contact with the chemicals during the time of processing, the chemicals that are giving up heat to the cooler air would, at the same time, receive heat from the 100° source. They would thus maintain the critical temperature constant.

Converting the Darkroom. Would you like to know how we provided a constant heat source in the darkroom to process color prints? Perhaps you will want to do the same. The first item required is a controlled source of 100° heat to pre-heat the CP-5 chemicals. We purchased a single-element hotplate from a local discount house for less than a buck. To control its temperature we installed a Johnson Model T-7912 Remote Bulb thermostat between the hot plate's heating element and the power line. Figs. 2 and 4 illustrate correct placement of the remote bulb on top of the hotplate.

The trick in maintaining critical temperature control of the chemicals is the use of a stainless-steel developing tray to hold the chemicals while they are on the temperature controlled hotplate. The steel tray will conduct the heat from the heating element of the hotplate to the chemicals.

To calibrate the temperature on the hotplate, we first filled the stainless-steel tray with water, since water gains heat very slowly and by the same token it loses heat at the same rate. The heating coils in free air gain heat rapidly and cool rapidly, but the ceramic base in which the heating coils are mounted retain heat for some time. One might expect this condition to cause the temperature to overshoot the thermostat's control limits. However, the location of the

BLACK & WHITE PROCESS					CP-5 COLOR PROCESS				
PROCESS STEP	REMARKS	TEMP. F	TIME	TOTAL TIME	PROCESS STEP	REMARKS	TEMP. F	TIME	TOTAL TIME
PRINT EXPOSURE 10 SECONDS					PRINT EXPOSURE 10 SECONDS				
1. Developer		68°	1.5	1.5	1. Developer		100±0.5°	2.5	2.5
2. Stop Bath		68°	0.2	1.7	2. Wash	running water	100±2°	.5	3.0
3. Fixer		68°	7.5	9.2	3. Stop-Fixer		100±2°	.5	3.5
THE REMAINING STEPS CAN BE DONE IN NORMAL ROOM LIGHT									
4. Wash	running water	68°	2.0	11.2	4. Wash	running water	100±2°	.5	4.0
5. Hypo-Elim.		68°	2.0	13.2	5. Bleach		100±2°	1.0	5.0
6. Wash	running water	68°	10.0	23.2	6. Wash	running water	100±2°	.5	5.5
7. Print Flat.		68°	5.0	28.2	7. Formalin		100±2°	.5	6.0
8. Dry	Ferrotype		15.0	43.2	8. Wash	running water	100±2°	.5	6.5
					9. Stabilizer		100±2°	.5	7.0
					10. Air Dry or Ferrotype		180° Max.	15.0	22.0

Chart details steps in processing both black-and-white and color prints. Total time shown is for handling single print; normally, several prints are done at same time, thus reducing per print average.

FIGURE 1. BLACK & WHITE PROCESS VS CP-5 COLOR PROCESS COMPARISON.

remote bulb and thermal gradients in the water combine to permit very accurate temperature control. Once calibrated, you can rely on the CP-5 chemicals being held at exactly 100° F.

The Thermostats. Before proceeding to the next step, perhaps you should have a little more information on remote bulb thermostats. There are two models available: the Johnson T-7912 and the Penn 7T11 remote bulb thermostats. The basic difference between them is their range of temperature control and their accuracy. The Johnson unit's control ranges from 100-220°, ±2.5°, whereas the Penn unit's range is 80-180°, ± 1.5°. It would appear that the Penn thermostat is the better one to use for maintaining temperature required for color processing. We selected the Johnson thermostat mainly because we wanted the higher temperature range for use on the print dryer. The ±2.5° accuracy will do nicely for color processing.

In addition to maintaining relatively constant temperature of the processing chemicals, the print dryer temperature must also be controlled. Therefore, the next step is to mount a thermostat on a print dryer. The thermostat is wired identically as for the hotplate. The remote bulb is positioned vertically inside the dryer between the two heating coils. Reason for placing the remote bulb in this position is to allow the radiant heat from both heating coils to offset the concentration of heat by the heating element's proximity to the dryer's surface. Fig. 3 details the Johnson thermostat mounted on the print dryer.

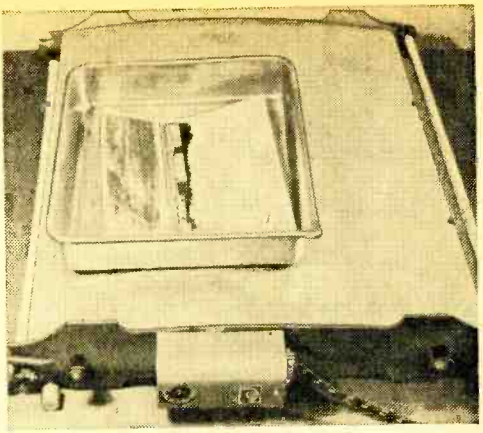


Fig. 3. Johnson thermostat mounted on print dryer. Remote bulb placed inside dryer offsets radiation from heater elements nearer dryer surface.

To calibrate the thermostat, place a stainless-steel developing tray containing water on the surface of the dryer. This done, bring the temperature up slowly until a water temperature of 100°F is obtained. It should take about one hour to stabilize the thermostat and calibrate the exact temperature.

Now that we've completed making and modifying our heat sources, it's time to give a little thought to the remaining details in the process of making color prints.

Before any processing is started, we suggest you purchase the Color Data book E-66, titled "Printing Color Negatives," published by Eastman Kodak, or the Kodak Color Dataguide No. R-19. These provide the detailed information on how to process color prints, how to correct your filter pack, and

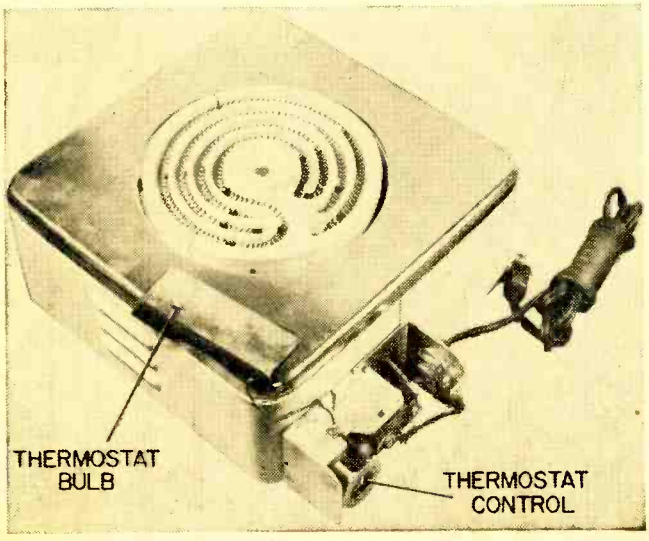


Fig. 2. Thermostat bulb placement is important to ensure proper heat control in order to maintain constant 100° source of heat. Chemicals held in contact with heat source give up heat to cooler air at same time they receive heat from hot plate. Quantity of each of chemicals needed to process prints to be made during a given printing period are kept in glass beakers placed in stainless steel tray on hot plate.

how to troubleshoot print defects. The Dataguide even provides you with a test color negative which is indispensable for color filter pack correction.

Test Strips. Fortified with Kodak's technical information on color, let's turn our attention to test strips. Kodak recommends keeping the exposure time constant and varying the light exposure by selecting different enlarger lens aperture settings. Reason for this is to eliminate potential problems due to the reciprocity characteristics of the color paper. In Fig. 5 you will note how the test-strip exposures were made. We made four masks for a Premier 4-in-1 easel so we could place them in or out of the easel to make each test exposure. If you would like to copy these test exposure masks, Fig. 6 gives the dimensions and materials to be used. Be sure to paint both surfaces with flat black paint to kill light reflections from the enlarger.

Now let's see what remains to be done before we can print color. Naturally we must have suitable containers to mix our stock solutions from the chemicals in the CP-5 kit. We used one gallon amber glass jugs for two reasons: 1) glass will not be affected by the color chemicals as could occur with plastic containers, 2) amber glass prevents light from affecting the chemicals. (Remember how Dektol darkens if left in clear glass containers?)

We numbered the stock solution jars 1 to 5 corresponding to their order of usage. We also numbered the 100-milliliter glass beakers in the same way. We used glass for the process chemicals because glass is a fair conductor of heat and will transfer the controlled 100° heat from the hotplate heated water to the chemicals in a reasonable period of time.

While on the subject of the CP-5 chemicals, it's advisable to caution you in their use. Pay attention to Kodak's WARNINGS

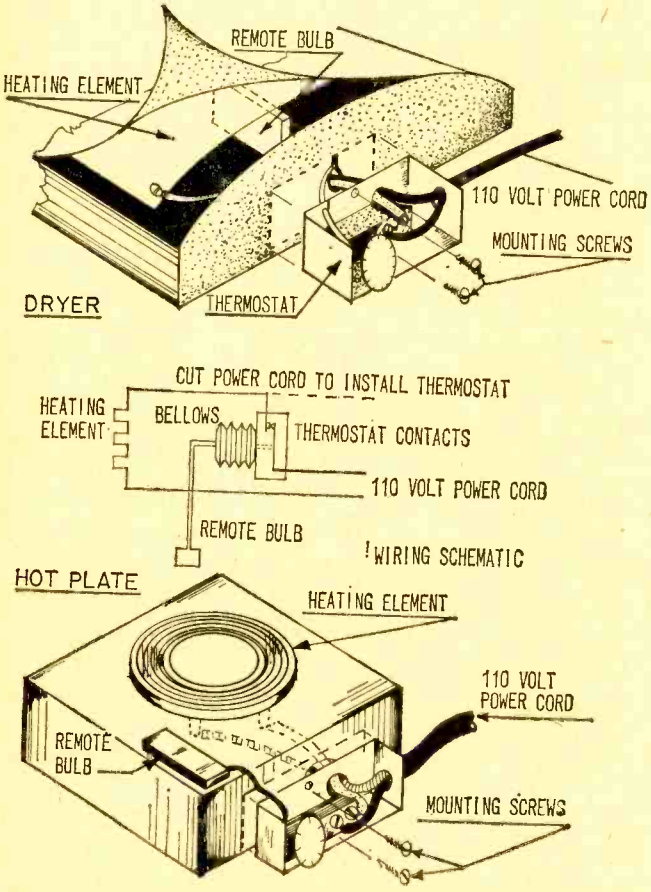


Fig. 4. Location of thermostat bulbs both in print dryer and on hot plate. Electrical wiring is same for both units. We used Johnson T7912 thermostat having control range from 100 to 220°, ±2.5°, for print dryer because its higher temperature range is more suitable for dryer. We used Penn model 7T11, whose range is 80 to 180°, ±1.5°, on hot plate. Its range falls in range required and it has closer temperature limit which is better for hot plate control. Be sure all connections are tight and all splices are insulated to prevent possible contact of bare wire with hot plate or dryer housings to avoid chance of accidental shock.

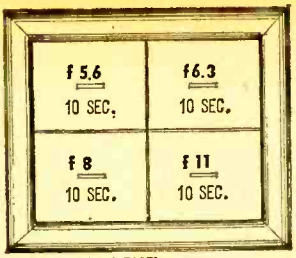


Fig. 5. Left, how masks are placed in easel for test exposures. It is suggested you follow same clockwise rotation of exposure at f stops indicated in drawing.

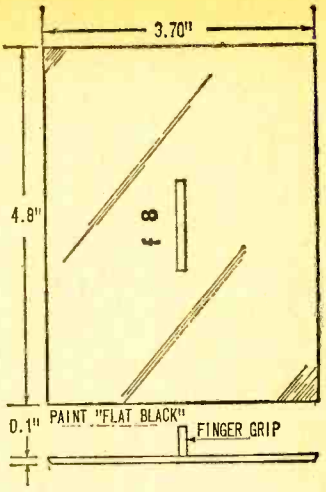


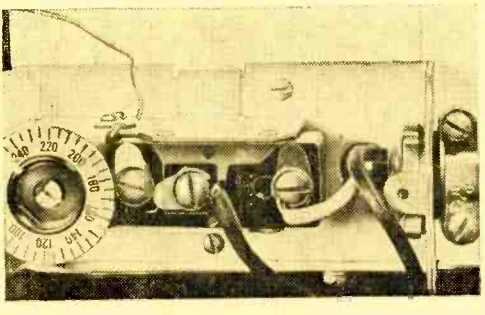
Fig. 6. Right, dimensions for making masks. You should be able to determine best f stop at fixed exposure within four tests from any negative to make good print.

Material: aluminum; fiberglass; or cardboard

printed on the packages and in the instruction sheets. These chemicals are very dangerous if handled improperly, but no more so than any chemicals used in photographic work. So be safe—not sorry—and take proper precautions when using CP-5. Here are a few suggestions for safe use of any dangerous chemicals:

1. Wear rubber gloves at all times.
2. Wear a protective apron to protect clothing.
3. Store glass containers in rubber or plastic jackets.
4. Provide adequate ventilation at all times.
5. In case of an accident, immediately flush exposed areas with fresh running water and have someone call a physician at once.

One more thing about darkroom safety, *never touch a water faucet while holding any electrical appliance!* Your enlarger, safelight, dryer, even your electric timer can cause a shock if normal precautions are not observed. Again, be safe! Never take chances with chemicals or electrical appliances.



Close-up view details connections to thermostat terminals. One side of heating element is connected directly to one side of power line cord; other side must be connected through thermostat to other side of 117-VAC line.

The following is a list of materials you will need to add to your darkroom to process color prints:

1. Series 10 dark amber safelight filter
2. Color printing filter set
3. Kodak color print processing kit CP-5
4. Kodak Ektacolor professional paper

Into the Darkroom. As soon as stock solutions are mixed with the CP-5 chemicals, you're ready to set up the darkroom equipment and get down to making color prints. A good arrangement for the darkroom, offering maximum convenience, is illustrated in Fig. 7. Note that with the safelight a minimum of 4 feet from both the enlarger and developing areas, you'll be able to work with the illumination from the safelight and not have to be in total darkness. The safety factor of a 4-minute exposure to the No. 10 safelight of the Ektacolor paper will provide you time to process the print through the Stop-Fixer. The remaining steps can be completed in normal room light.

First step in making the test exposure strip is to build the basic color filter pack. The first filter, which always remains in the pack, is the UV (ultraviolet) filter. To this filter we add a number of filters to build a value of 50 RED. A typical combination would be 40 RED + 10 YELLOW + 10 MAGENTA (10 YELLOW + 10 MAGENTA = 10 RED).

Insert a sheet of Ektacolor paper in the easel and cover it with the four masks. Set the timer for a 10-second exposure, using the light of the No. 10 safelight. Make separate exposures at lens aperture settings of 5.6, 6.3, 8, and 11. Remove the mask with identification matching the lens setting for each exposure and return it to its original loca-

e/e CONVERT TO COLOR

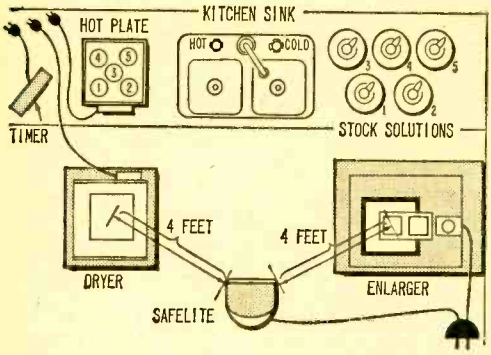
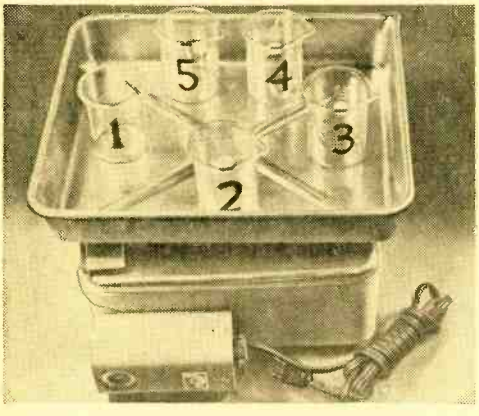


Fig. 7. This typical darkroom layout provides maximum convenience in working conditions. Safelight is positioned for safety factor of Ektacolor paper.

tion immediately at the end of the 10-second exposure period.

With the initial test exposure made, you're now ready to process your first color print. Place the print, face up, in the stainless-steel tray (plastic trays will not conduct heat satisfactorily). Now pre-wet the print with 3 oz. of water heated to 100°F. This brings the tray and print up to the proper temperature. Set the timer for 7 minutes and throw away the water used to pre-wet the print and place the tray on the heated dryer. (Of course you have preheated the chemicals by placing on the hotplate a stainless steel tray containing water and the beakers containing the chemicals).

Take No. 1 beaker containing the heated



Solutions used during processing kept in 100 mm beakers placed on hot plate to maintain proper temperature. Beakers marked same as brown bottles.

BILL OF MATERIALS

1—Set Color Printing Filters as follows: 1—40 red, 1—20 yellow, 1—10 yellow, 1—5 yellow, 1—UV filter, 1—20 magenta, 1—10 magenta, 1—5 magenta (Note: this is the minimum set of color printing filters; you may want to add to the minimum for better color correction.)
5—100-milliliter glass beakers or 3-oz. glass drinking glasses
5—1-gal. amber glass stock solution containers
1—Single-element hotplate
2—Johnson or Penn remote bulb thermostat (see text)
*1—Kodak CP-5 color processing kit (1-qt. size)
1—Package Kodak Ektacolor professional paper
1—Series 10 safelight
2—Stainless steel developing trays, 8 x 10 in.
* When packaged in kit form chemicals are supplied in quart size only. However, the five chemicals are also available in individual 1-gal. size packages.

Stock solutions are stored in brown bottles marked to identify the order of their usage. Dark bottles protect chemicals from damage caused by light.

developer and pour 3 oz. on the center of the print. Now rock this tray on the dryer to allow the developer to flow continuously across the print. In addition to constantly flowing fresh developer over the print, the rocking of the tray continually transfers heat from the dryer into the developer.

Remember—each step will require 5 seconds for draining in addition to specified process time, so make allowances for draining time in each step. This is a very fast process, and of the nine process steps all but two take just 30 seconds each. Only the developer and bleach steps require more than 30 seconds.

After completing the first color print you'll be anxious to see the results of your work. Take a close look at the wet print.

(Continued on page 102)

ELEMENTARY EGOTRONICS

by Carl Kohler

The following exercise is a pseudological series of theoretical *life situations* which might face any electronics enthusiast. The purpose of this simplified test is to help you determine, for yourself, approximately how much self-control you might possess under various pressures. Unless you take yourself too seriously, you're in no danger of being warped by this exercise. At the conclusion of each of the life situations check *one* response or write-in your own response to each situation. You'll find a rather wild scoring system. Should the results please you, share them with your family and friends. But should the final score enrage you, direct all poison pen letters to me c/o ELEMENTARY ELECTRONICS and stay off the Editor's back: by including this feature he was only proving that he's courageous enough to try almost anything at least *once*.

Good Luck and don't hesitate to cheat!

★ ★ ★

1. For years you have assiduously collected electronic components that are either no longer on the market or very difficult to find, carefully stashing them in a large crate in your garage. One day you discover that your wife—thinking the crate contained discarded clothing—gave it to the Salvation Army.

Would you:
A. Calmly begin another collection?
B. Regard the experience as a religious contribution?
C. Become hysterical?
D. Join the Salvation Army, hoping to track down the crate?
E. _____

★ ★ ★

2. There are two electronics supply shops in your locality. Shop-A is spacious, clean and offers mild savings with discounts on almost every item. Shop-B is a hole-in-the-wall but the sales-clerks are young and shapely females wearing ultra-miniskirts and provocative expressions who bend over a lot.

Would you:
A. Buy all your supplies at Shop-A?
B. Do all your window-shopping at Shop-B?
C. Berate the manager of Shop-A for hiring male clerks?
D. Get fresh with the help at Shop-B?
E. _____

★ ★ ★

3. Your sincere and dedicated interest in solid-state theory has gradually given you a well deserved reputation for having become a minor expert upon the subject. When you are invited to speak upon your favorite subject before a large audience of fellow enthusiasts, you no sooner get to the rostrum than your mind goes totally blank.

Would you:
A. Laughingly explain your predicament to the audience?
B. Smoothly switch to a faked-out talk on Ovonics?
C. Tremble, perspire and break into tears?
D. Sprint for the nearest exit?
E. _____

★ ★ ★

4. Having designed, constructed and installed a most original burglar alarm system, you find that because it keeps shorting out for a variety of technical reasons you aren't getting any sleep.

Would you:
A. Replace it with a more conventional system?
B. Stubbornly modify it from sound-signal to light-signal?
C. Replace it with a large surly dog?
D. Refuse to do anything except buy ear-muffs?
E. _____

★ ★ ★

5. Carelessly forgetting to lock the door to your workroom, you return home from work to discover that neighborhood children have made a shambles of all your equipment, supplies and your latest electronic project—a scratchbuilt low-power rig with which you planned to operate the 40-meter band in your off-hours.

Would you:
A. Sternly remind yourself to lock the door after this?
B. Calmly build another, stronger rig to work skip with?
C. Rage and fume silently until you had an ulcer of your very own?
D. Palm off the kids to the Gypsies at wholesale rates?
E. _____

★ ★ ★

6. You meet a gorgeous doll and have fallen madly in love with her when *(Continued on page 101)*

HOW TO BE A P.A. PATSY...

Public-address systems never seem to work quite as intended, and electronics buffs are frequently expected to perform major miracles with them. The following tips should help the miracle-worker.

Ten minutes to starting time. The Royal Grand Potentate has come all the way from Crows Canyon for the annual lodge banquet, and you know what a reputation he has for laying 'em in the aisles. The MC makes a perfunctory check of the public address system with the *one-two-three* testing routine. *Nothing happens!*

Normally stable as the Rock of Gibraltar, the MC is suddenly reduced to panting panic as he hammers the mike and hollers for the manager. And then his eye lights up with the hope of desperation as he spots you, the lodge electronics hobbyist, at a forward table. Suddenly it's *your* tub of transistors.

Enter Thinking. You make sure the mike's own switch is *on,* and you work it back and forth to clear the contacts. You gently tap the microphone after tightening the cable connector on the mike head, and you finally determine the system is truly a corpse. The connector at the other end of the cable is firmly snapped into the audio wall socket. A harried scan of the room discloses the amplifier on a shelf at the rear. The red pilot light shows the AC is OK. The mike volume control and master gain pots are set near mid-range so up to here, all systems are go.

You gently slide the amplifier around and see no unattached wires hanging loose and no stray strands shorting the loudspeaker-connection screws. Turning *off* the power briefly, you tighten the screws with your nail file or pocket knife and firmly seat the two mike connectors.

Two mike connectors? You dash to the other microphone—the one for the guest speaker—and *Eureka!* It works! So while a hastily recruited lodge brother talks into the good mike, you identify the defective channel at the amplifier by disengaging the mike cable connectors one at a time and noting when the signal stops. Then putting your finger on that channel's now-exposed single (Amphenol) or triple (Cannon) mike input terminals on the amplifier, you get a satisfying buzz from the speakers.

So you now know the amplifier channel is good and the mike or its cable is bad.

by Eugene F. Coriell,
Lt. Col. USAF-Ret.

By this time, the assistant manager has arrived. In no time at all, he sets up a spare mike and waves good luck as he hastily departs to answer a paging call.

Pause Smiling. You heave a mighty sigh. The MC looks ten years younger as he confidently repeats his test routine—and promptly ages again as the system howls into feedback. As the guest speaker enters, the MC tosses the ball of wax back to you. So what now, Marconi?

Feedback, hmmm. Maybe in checking over the amplifier connections, you accidentally advanced the mike pot? No, it's OK but you drop it a bit. No dice. Another slight drop, and now the howl is gone, and so is the needed volume. Could the tone control have been jostled down into the bass region where feedback is most likely?

Nope, it's right in the middle of the range. Then your eye falls on the MC's replacement microphone and you notice it looks a bit different from the original. In fact, it's a non-directional unit and it's picking up some of the loudspeaker output that was blocked out by the original directional mike.

So you mentally tick off possible solutions as the guest speaker is being escorted up the aisle toward the head table. You could turn down the gain to reduce system sensitivity and have the MC buddy up to the mike to compensate. Or you could raise the mike higher on its stand and angle it downward, hoping for a little instant directionality.

But wait a minute. Here comes the assistant manager again and he's carrying the original mike. Beaming, he puts it back on the MC's stand and explains he soldered a broken connection in the connector receptacle. And gratefully you hear the clear, ringing tones from the loudspeakers, "Ladies and gentlemen . . ."

Act II. In show business, they'd call this happy solution a contrived ending. But now let's put the shoe on the other foot in a situation where any contriving may be strictly up to you. Let's say that, well in advance, your lodge had the good sense to make you their sound liaison man with the hotel. So

you approach the manager via the public-relations route and explain that the lodge has asked you to offer cooperation in meeting the sound needs of the meeting. Since this has probably never happened before, you have thereby earned a good question-and-answer session with one of his aides, perhaps the hotel engineer.

For your particular table and seating arrangements, where will the mikes be plugged in and what types are available? Where is the amplifier located and what are the normal ranges of the gain and tone pots? Can the mikes be seen from the amplifier location? Where are the speakers to be located? Sometimes they are fixed in place, with some or all hidden in the ceiling.

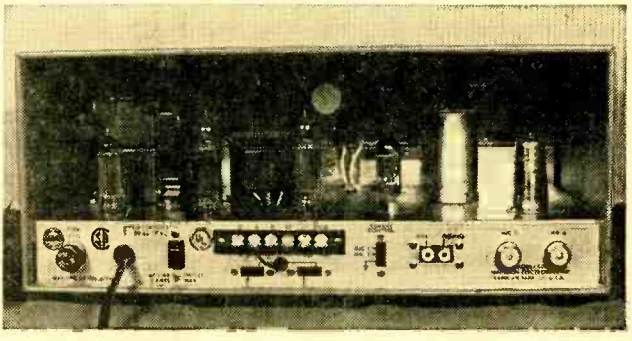
What is the range of movement of any speakers that can be relocated if necessary to reduce feedback or fill in dead spots? And you ask to have the hotel paging system disconnected so that Maizie at the switchboard can't come booming in over the climax of the guest speaker's best joke.

Dress Rehearsal. You then diplomatically ask to try out the system with the types of mikes you want, placed where you want them. You ask for the directional type as feedback insurance, and this includes the audience traveling mike. With the mastergain and tone-control pots set at mid-range, you note down the position of each mike pot for maximum volume before feedback occurs.

All mikes are *on* for this test. If this volume is adequate in the empty room, you figure there should be no howl problem with a full house, since an audience absorbs sound. Any additional volume needed then is obtained by carefully inching up the master gain without disturbing the individual mike pots.

Listening critically, you note the absence of hum but detect some crackling when using one of the mikes. With the hotel man nodding assent, you note that the cable is snug in the mike head and that tapping the instrument causes no crackling. But flexing the cable as you walk toward its wall receptacle, you suddenly come to a point that really makes the system bark.

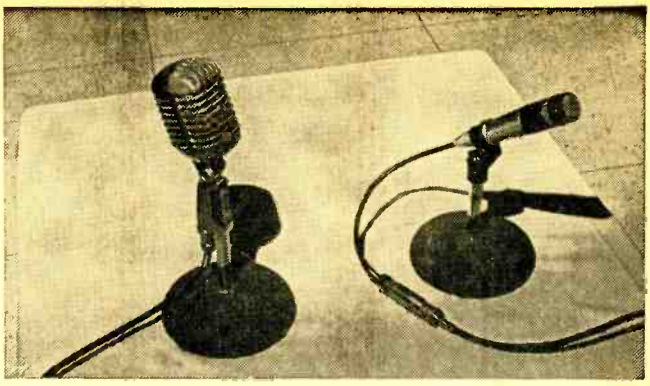
Too many hotel dish carts have been rolled over that cable, and your guide notes the need for a new one. The other table mike seems to cause pops, particularly if you get too close to it. Sadly you agree replacement is in order.



Rear of S20 reveals two mike inputs of Amphenol type at far right, remote control connector at right of speaker terminals. Latter is for pots to control mike volume.

Typical of public-address amplifiers is Precision Electronics' Model S20. Power Monitor (extreme right) is neon lamp which flickers when pots are set for desired output.

Trying out the traveling audience mike, you notice it causes howling when carried under any of the ceiling speakers. You learn that, unlike some installations, these speakers have no cut-off switches. This means that you'll want the mike man practically pushing the microphone into the users' faces

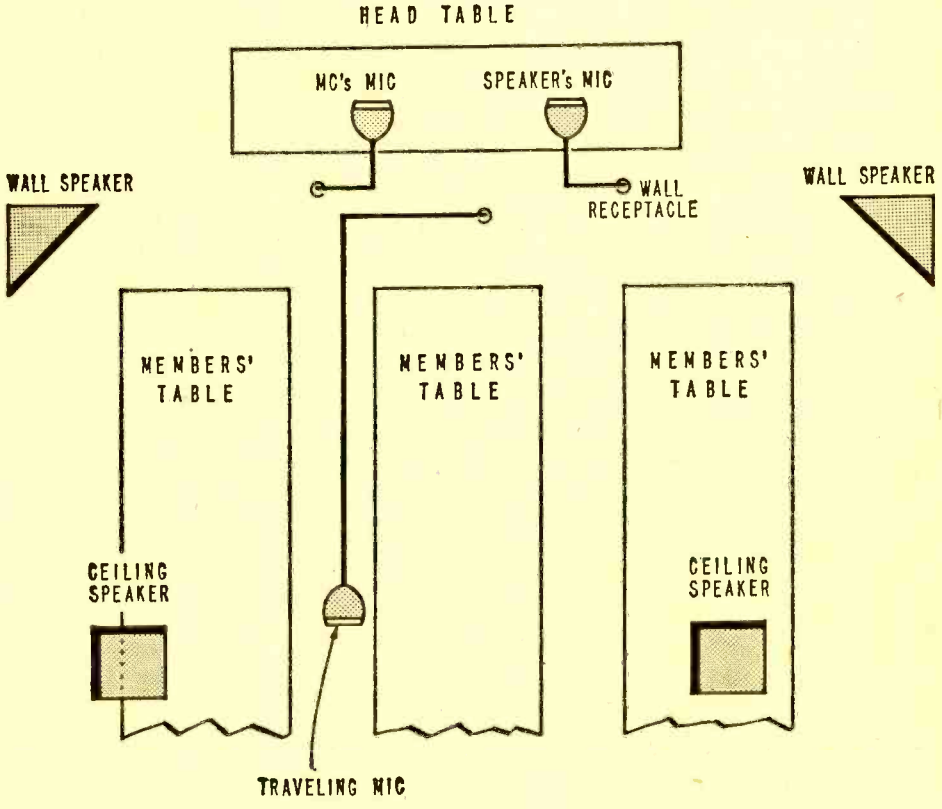


Two directional mikes in Shure's Unidyne series. Left, Model 55S accepts cable plug-in connector on threaded collar; right, Model 545 has cable-mounted connector.

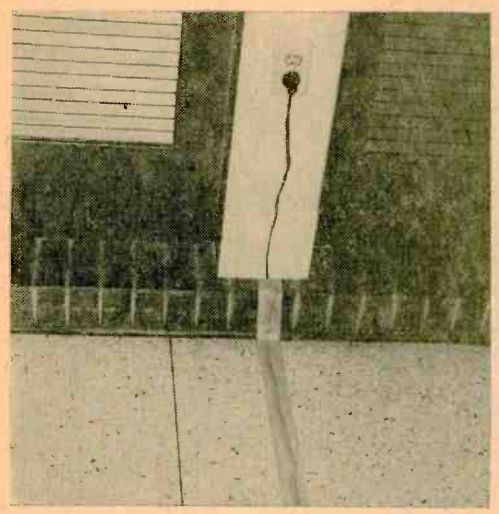
to permit minimum gain setting to discourage feedback. And this reminds you to have someone assigned to that mike, and also an operator at the amplifier you'll maintain liaison with as the sound scout. Here you recall there may be a union and you make your arrangements with the hotel man accordingly.

A Show For Sure. And now you foresightedly consider what to do if trouble occurs on the big night. If the hotel furnishes an operator (this is unlikely in smaller establishments), you're in his hands. If the lodge is graciously permitted to handle the amplifier, any fast fix needed is likely to be your baby—if only because the emphasis is on *fast*.

If the system conks out completely, maybe some wise guy pulled the AC plug or a mike connector. Or maybe the amplifier innocently blew a fuse. If the fuse isn't plainly visible, you ask the hotel man for its location, along with a spare fuse which you tape to the amplifier. The fuse has been known



Ideal public-address setup for banquet hall looks something like this, with wall and ceiling speakers aimed well away from mikes. Properly set up and tested ahead of time, PA system should give no trouble when it's call on to deliver its all-important goods.

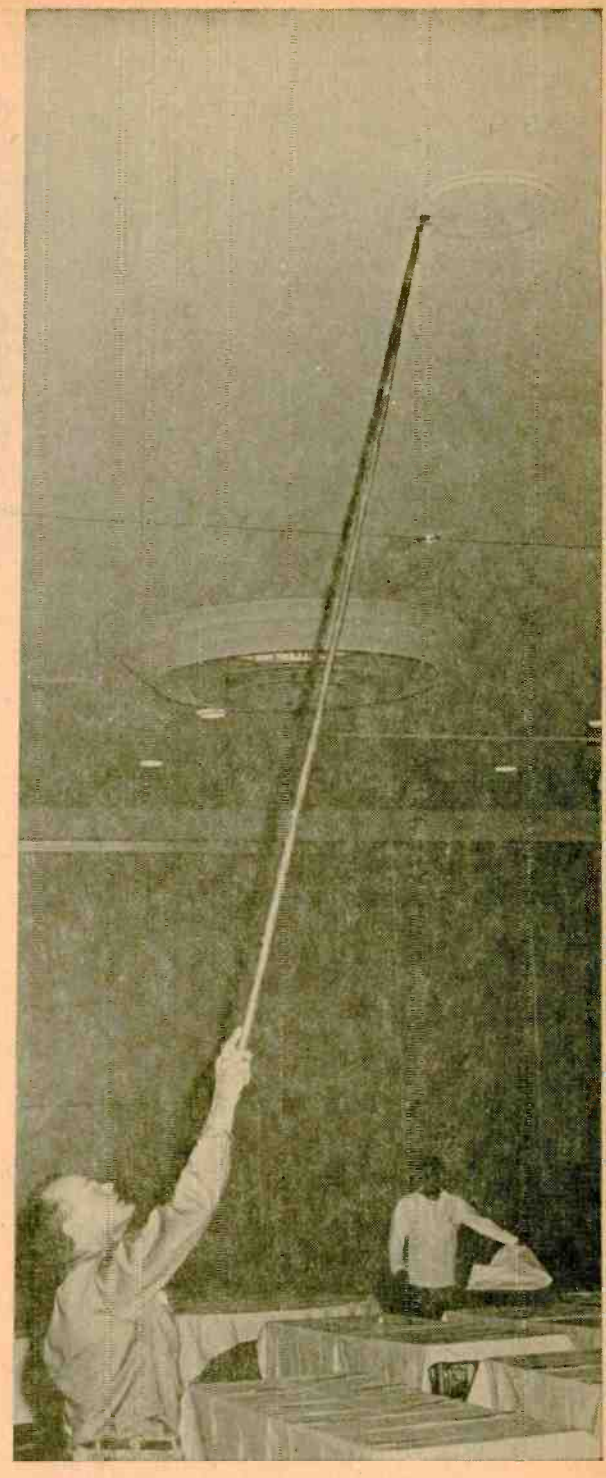


Leaving exposed cables and cords around banquet hall is asking for trouble. Best bet is to tape down all floor cables—those for microphones and speakers —as well as all AC line cords with painters' masking tape to avoid possible accidents.

to be hidden in the body of the AC plug.

And what if that old devil Hum should loudly assert his dominion? You'll promptly try reversing the AC plug in the wall socket, and make sure the pot on any unused channel—including a phono input—is all the way *off*. You'll make sure any grounding wire to the amplifier chassis is tight. If these tricks don't work and the hum is bad enough to warrant the interruption, you'll kill each mike pot in succession. If this points up a bad channel, you'll plug into a spare channel if any, or commandeer the traveling mike. Or you'll turn down the gain on the offending channel and ask the speaker to talk closer to the mike to improve the signal-to-hum ratio. But if the trouble is not in one of the mike channels, you'll rap the amplifier smartly—just in case—and/or turn down the tone control to minimum bass and ride out the storm.

And on banquet night, you'll firmly tape all exposed cables to the floor and all table mike cables to the table legs, using 3-in. painter's masking tape. Thus do you prevent mikes, members, and MCs from becoming accident statistics. And thus does your overall planning assure the Royal Grand Potentate will truly lay 'em in the aisles—because the sound system will lay no eggs. ■



Individual ceiling speakers in some halls are equipped with cut-off switches to control feedback. Reached with what hotel employees refer to as skyhooks, switches can save the day for the PA patsy.

QUICK-'n-DIRTY BATTERY-POWERED P.A.

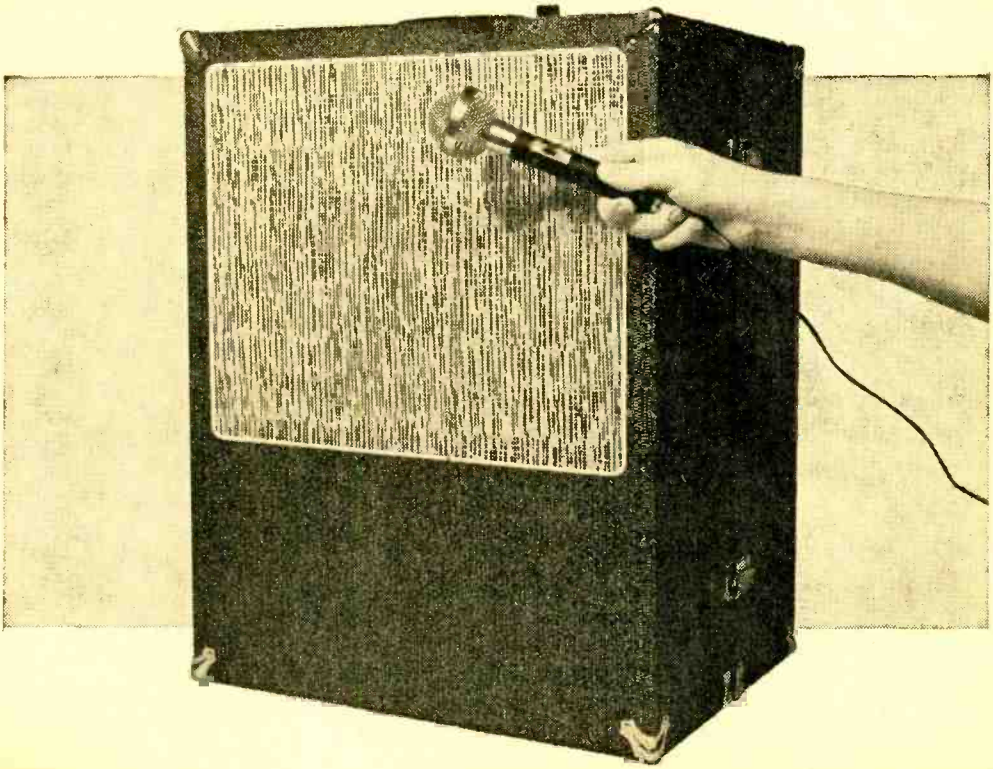
by Herb Friedman, W2ZLF

Just about every organization can use a really portable PA system—one powered by batteries, not the AC line. For whether it's a teen bash in the church garden, a CB or ham jamboree in the boondocks (miles from AC power), or a school dance on the terrace or roof, a battery-powered PA fits in neatly as a round peg in a round hole.

Using a ten-buck solid-state amplifier as the basis, in less than an evening you can throw together a lightweight, portable PA system equal to or surpassing much commercial equipment. The performance of the unit you build will be tailored specifically for your needs, because you select the quality of the ancillary equipment.

Options Galore. For example, if you need a very lightweight portable PA of decent quality, you simply build the amplifier into a small 8-in. speaker baffle and use a decent-quality, 8-in. speaker. If you want a really top-flight system with excellent sound quality, suitable for good music reproduction, you simply use a large PA cabinet and high-quality PA-grade, 12-in. speakers. You can tailor the system to your individual needs because the amplifier itself is basically of good quality, thereby allowing you to control overall performance by your choice of speaker and microphone.

The amplifier, McGee Radio type KA-500, is rated at 4.5 watts output at 10% distortion. But unlike most solid-state amplifiers



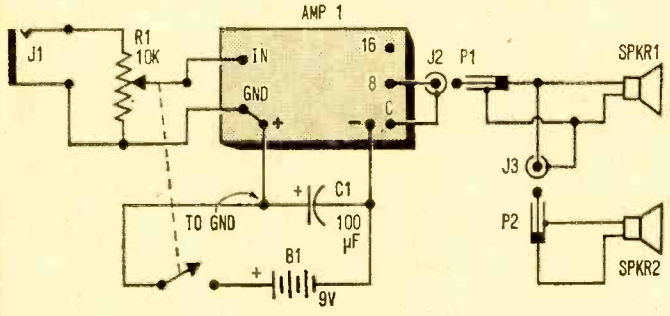
which limit at the clipping point, the KA-500 can be driven to 7 watts output, though with considerably more distortion.

But even with the higher distortion, the amplifier does a good job in PA service. (PA system distortion is normally much more than that of hi-fi systems.) The KA-500's input sensitivity is 15 mV, more than needed for even low-efficiency microphones. Because a volume control is used ahead of the amplifier input, a high-level sound source, such as a tape recorder, can be used without fear of overloading the amplifier input. Finally, since the idling current is only 50 mA at 9 volts, with peak current of less than an ampere, the amplifier can be powered by easy-to-obtain D cells.

Though miniature in size, PC amplifier can pump out 7 watts of "voice power." That's enough for most groups of under 250 people.

Easy Does It. A typical high-quality portable PA assembly is shown in our schematic and photos. Even if you don't choose to utilize the large cabinet and speakers shown, use the electrical connections shown in the schematic. In particular, don't try to use the microphone cable's shield as one side of the power source, since the amplifier will break into oscillation and may self-destruct. Use a separate wire for the positive battery lead even though it connects to the same ground foil as the microphone shield. (Yes, the *positive* battery lead is grounded in this amplifier!)

Regardless of the cabinet and speakers used, prepare the amplifier for installation before you do anything else. All amplifier connections are made directly to the pads provided on the amplifier's PC foils; a pictorial of the PC wiring is supplied with the amplifier. Begin by connecting about 5 ft of shielded mike cable to input pads. This done, connect a red wire to the positive power supply pad and a black wire to the negative power pad.



Simple? You bet it is. Just add a handful of standard parts to a ready-made, goof-proof amplifier and you and your PA will be invited to many free dinners. If you wish, a 9-volt battery eliminator can be placed across B1 to add battery boost and charge when unit is operated near AC supply.

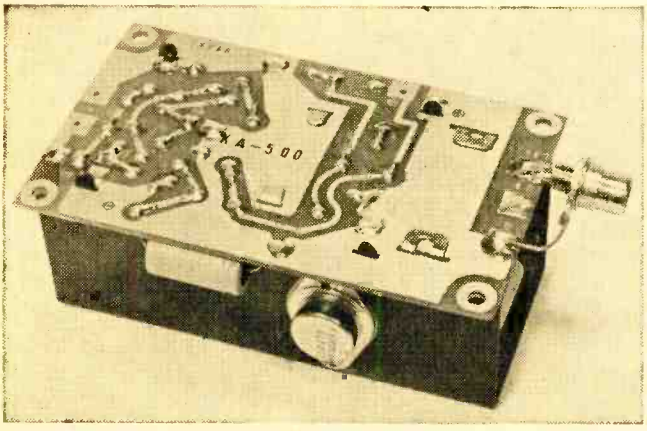
PARTS LIST FOR BATTERY-POWERED PA

B1—9-V battery (6 D cells in series or equiv.—see text)
C1—100-uF, 15-V electrolytic capacitor
J1—Open-circuit phone jack
J2, J3—RCA phono jack
P1, P2—RCA phono plug
R1—10,000-ohm, audio taper potentiometer
S1—Spst switch (can be part of R1—see text)
2—Speakers (see text)
1—PA amplifier (McGee Radio KA-500 or equiv.)—McGee Radio Co., 1901 McGee St., Kansas City, Mo. 64108
1—Portable PA cabinet (Lafayette 44T0126 or equiv.)
Misc.—Battery holders, terminal strip, screws, spacers, etc.

Speaker Connections. To facilitate changing speakers, solder the center terminal of a phono jack directly to either the 8- or 16-ohm speaker output pad and a wire from the *common* speaker pad to the jack's frame. Use the 8-ohm speaker connection for a single 8-ohm speaker or for two 8-ohm speakers in parallel (4 ohms parallel impedence). Better results are obtained with two 8-ohm speakers if they are connected in series to the 16-ohm speaker output. Though we show a single speaker jack in the photo, a jack can be soldered to both the 8- and 16-ohm pads if desired.

Assuming you use a portable PA case such as the Lafayette 44 T 0125 shown in the photo, remove the amplifier board from the bottom of the cabinet by gently tapping with a hammer on the underside of the board. (Four small nails hold the board in place.) Next, mount the amplifier to the board using wood screws and ¼-in. spacers, or a stack of washers, at each mounting screw. You must use spacers between the amplifier and the board, since the PC board may crack if you try to mount the amplifier directly to the board. Leaving room for a terminal strip, install either three twin-D or six single-D battery holders near the amplifier. See photo below.

Wire the battery holders in series so that 6 D-cells give 9 V output, and connect the battery supply and the power wires from the amplifier to the terminal strip. Make certain you install capacitor C1 across the amplifier power wires at the terminal strip. (If C1 isn't included, the amplifier can break into oscillation when the batteries age.) Set the board aside.

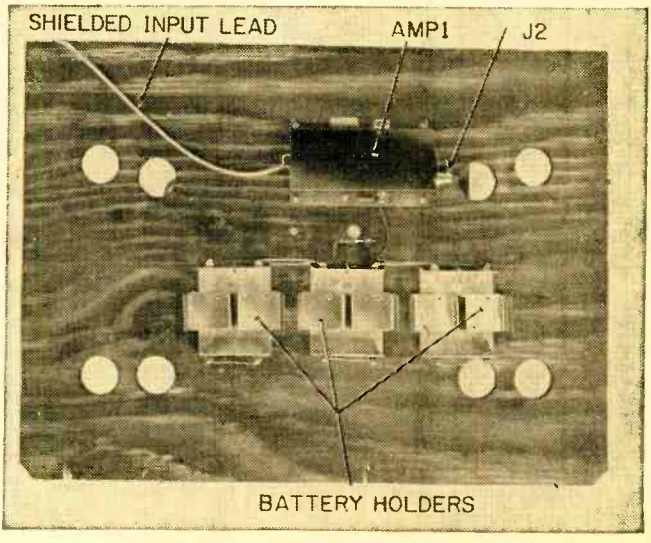


Here's upside-down view of 7-watt amplifier that's heart of battery-powered PA system. Connecting wires are soldered directly to copper pads on printed circuit board; center conductor of output plug is soldered directly to foil, making jack integral part of amplifier assembly.

Next install the speaker(s) in the PA case. We suggest quality PA speakers such as the Lafayette type 44 T 0102, shown in our photos. Locate an area on top of the cabinet for the volume control and input jack as far as possible from the speaker.

Better with Brackets. In almost all instances the shafts on the volume control and input jack won't be long enough

(Continued on page 56)



Amplifier is mounted directly on wooden baseplate supplied with PA speaker cabinet. Be sure shielded input lead is long enough to reach volume control when baseplate is inserted into speaker cabinet. Class-D battery holders are positioned like soldiers for easy battery replacement. Note that there's plenty of room to add battery eliminator for 117-VAC operation.

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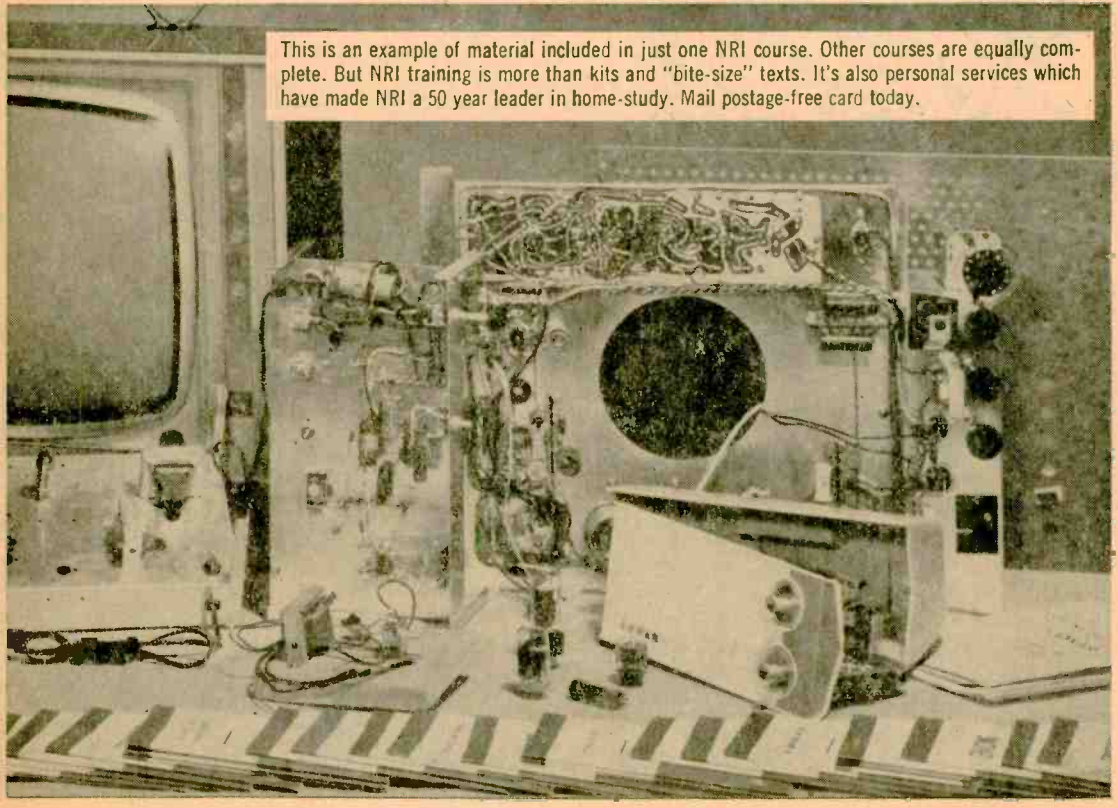

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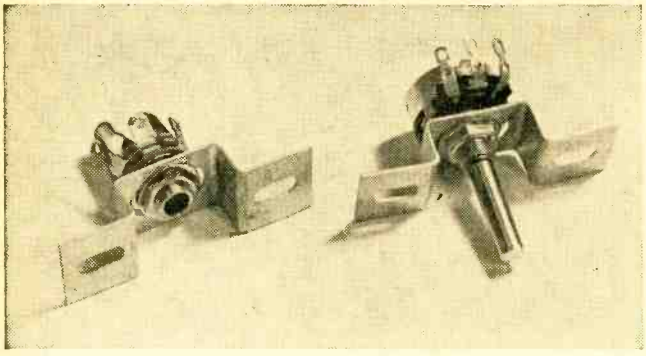
Continued from page 51

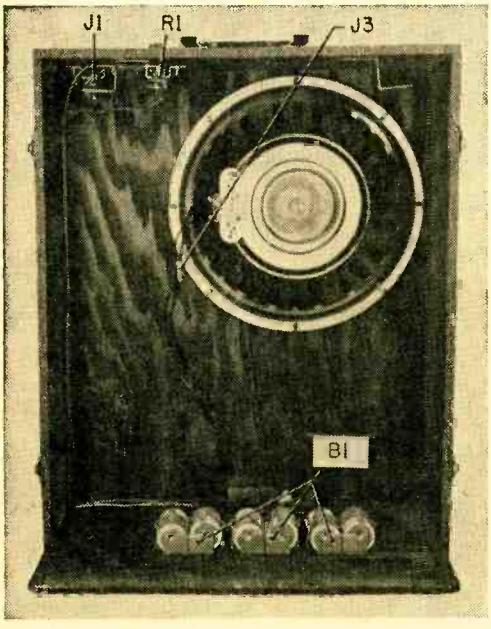
to pass through the top of the cabinet. Rather than undercut the cabinet, which would weaken the area around the control and jack, use Mallory type RB248 or RB 249 mounting brackets to secure the parts. First, mount the control and jack on the brackets as shown, using a lock washer between the part and the bracket. This done, drill a ⅜-in. hole in the cabinet to clear the control's shaft, and a ⅝- or ¾-in. hole to clear the shell of the connecting phone plug.

Secure the control and jack assemblies to the cabinet with flat-head #6 screws. The brackets have slotted holes, allowing the assemblies to be positioned so the control shaft and plug shell are centered with respect to the cabinet holes. The power switch can be mounted directly on the cabinet or it can be part of the volume control; the option is yours. No pilot light is provided since it would only increase battery drain.

After all cabinet components are mounted, install the amplifier board and connect the cabinet components to the amplifier. If you use two speakers, run polarized zipcord for the speaker connection. Make the *copper* wire the P1 "hot" lead (center conductor) and the *silver* wire the ground connection. Note which speaker terminal has the copper wire and connect a phono jack at the speaker with its center conductor connected to the copper wire speaker terminal; this jack will be used for connecting the second speaker. Make certain the same terminal on the second speaker has copper wire, and that this wire connects to J2's center conductor.



Since volume control and input jack shafts aren't long enough to pass through top of speaker cabinet, mount these components on control brackets as shown at left using lock washers. Secure brackets to cabinet with #6 machine screws. Do not use wood screws that have insufficient length.



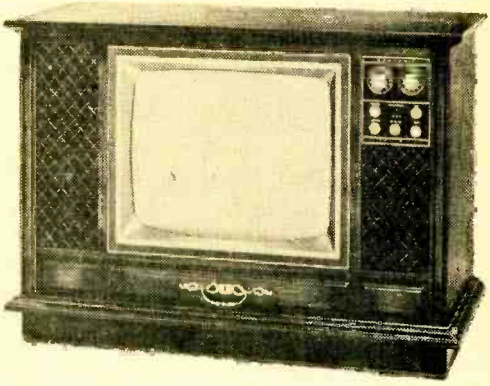
This photo gives good idea of how long input shielded cable must be to reach volume control R1. Be sure to staple all leads to cabinet's wooden sides.

Mikes and Batteries. High-impedance crystal or ceramic microphones are out for this hookup, since the 10-k volume control loading will wipe out the mike's low-frequency response. Any dynamic mike with an impedance in the range of 50 to 50 k ohms will work satisfactorily; best results are obtained with 250- or 600-ohm mikes, though the differences will be small.

While ordinary D cells can be used, the alkaline type will give 3 to 5 times the life per set of batteries. If you prefer an AC power option, any 9-V supply capable of delivering 800 mA peak current can be used. ■

e/e PRODUCT TEST

HEATHKIT MODEL GR-681
Remote Control
Color TV Set



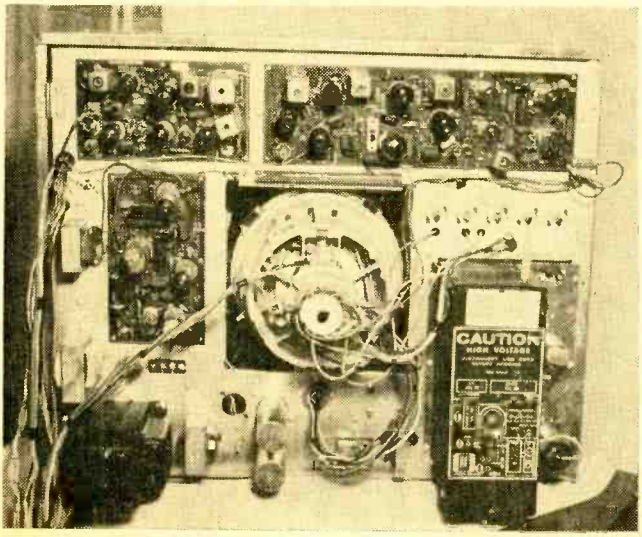
You can buy a good color TV just about anyplace. But regardless of how much you're prepared to spend, you can't buy a *great*, production-run color TV. The only way you can get truly great color performance is to build the set yourself . . . a Heathkit color set; in particular, the Heathkit 295-square-inch, short neck, model GR-681. (*Short neck* means that the color set is no larger than a black-and-white TV of equivalent tube size.)

Many of us in electronics, particularly those who handle literally mountains of equipment, have used the Heath color TVs as the standard of comparison for color sets. For the Heathkits produce neither garish nor washed-out color; rather, they're known for their soft, fully saturated color pictures. In the GR-681 chassis the Heath people have maintained their superb color reproduction, and they have added excellent color stability through the use of *automatic fine tuning* (AFT).

A complete GR-681 color set really consists of three separate kits. The basic kit is the GR-681 color chassis that includes a wired remote control with power *on/off*, and channel switching. The second kit is the GRA-681-6 wireless remote control, which allows remote wireless control of the power *on/off*, volume level, channel, tint, and color (hue). The wireless control can be added during the construction of the chassis or at a later date, though for reasons we'll explain later the wireless control should be added at the time the chassis is built.

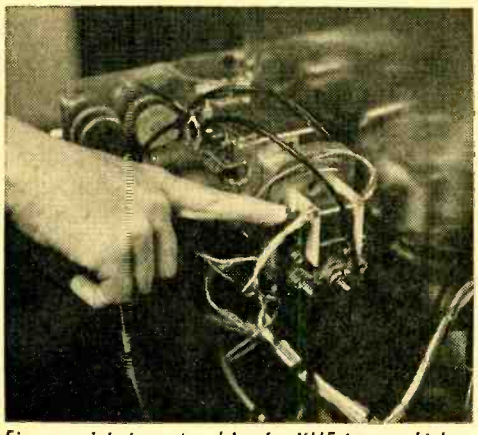
The third kit consists of the optional enclosure, supplied with a fully-assembled and finished cabinet. For those who prefer custom mounting, Heath supplies custom cutout and mounting instructions in the assembly manual.

Features & Features. You name it . . . the GR-681 has it. Fact is, it even sports a feature you haven't thought of: a built-in dot generator so the user can do his own color alignment or trimming. (And you save approximately $35.00 each time you do your own color adjustments.) Other features include automatic



Completed chassis (tuner and convergence panels are not shown). High-voltage (horizontal) section (lower right), supplied aligned, has performance certification sticker.

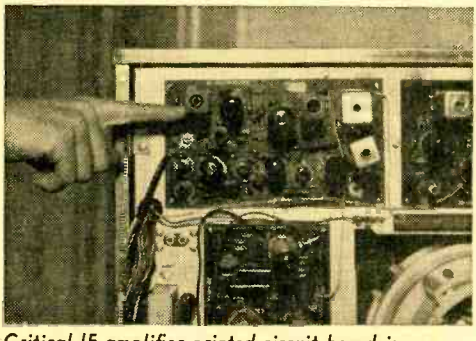
HEATHKIT COLOR TV



Finger points to motor drive for VHF tuner, which is part of basic chassis package. Same motor and wiring are used if you add wireless remote control.

CRT degaussing, a front-mounted color convergence panel (behind the speaker on a swing-down door), pushbutton and manual tuning, both 300- and 75-ohm antenna inputs, a low-pass filter for the tuner, and —best of all—AFT.

By way of explanation, AFT is akin to the AFC of an FM tuner. When the AFT switch on the back of the brightness control is pushed in, both the vhf and uhf tuners are electronically locked to the correct tuning via varicap capacitors in the tuner oscillators. Even if you haven't adjusted the manual fine tuning correctly, the AFT locks the tuning. In fact, the manual fine tuning is only used to check the AFT when construction is completed; it need never be touched again. Since color reception is extremely sensitive to oscillator tuning, the importance of AFT is obvious.



Critical IF amplifier printed-circuit board is supplied completely wired and aligned. Other circuit boards are non-critical and user-assembled.

A small but convenient feature is an audio output jack for connection to your hi-fi equipment—this, incidentally, in addition to the normal speaker output jack.

Can You Build It? Naturally, when you consider that the GR-681 chassis kit represents $500.00 worth of individual parts, you might have some reservations about tackling a color TV kit. Fear not, for the GR-681's assembly manual is perhaps the finest kit manual ever produced, as is the assembly layout. It is so good, and so easy to follow, that a section which appears to be picked up from an earlier kit sticks out like a sore thumb. This is the convergence panel, which has a few components that barely fit into place. Luckily, this problem is not true anywhere else in the kit. Further, the convergence panel is non-critical and you won't go wrong.

As long as you have the ability to read, and you use two proper-wattage soldering irons, you will end up with a working color set. Fact is, proper soldering is the key to construction. Use a 40- to 50-watt iron with a ⅛- or 3/16-in. chisel tip on the printed circuit boards, and a 100- to 200-watt iron or 250-watt gun for the chassis connections. You can't get a good chassis connection with a 40-watt iron, and a high-wattage iron or gun will ruin the PC boards. Consider the cost of the correct soldering irons as part of the kit cost.

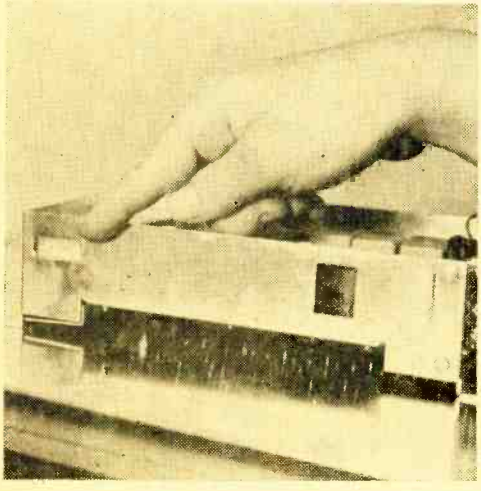
Actually, all the critical work has been done at the factory. The vhf and uhf tuners, the IF amplifier board, and the high-voltage section are supplied completely factory-wired and aligned. You assemble only the color and sync circuit boards, convergence panel, power supply, and interconnections. Several factory-assembled wiring harnesses are provided.

Wireless Control. When wireless control is used, the tint and color controls are adjusted by small motors mounted on the backs of the controls. The motors are supplied with the remote control kit, not the color chassis, and it's one frustrating and difficult job to substitute the motor controls after the kit is completed. Hence, it's advisable to purchase the remote control kit with the chassis kit. Then, when you get to the installation of controls FJ and FD, you can install the motor controls from the wireless control kit. The remote control takes roughly 20 minutes to install if you have the motors in from the beginning. Otherwise, you suffer through an hour or two of sweat and tears.

Remember, it takes time to build a color set—from 25 to 40 hours, depending on your experience. And don't forget to add another hour or so for first color alignment. We say first alignment, because unlike a store-bought color set with a short burn-in time that can produce color drift, you'll be wanting to allow the Heathkit to burn-in for two weeks. After this, you'll again align the color circuits, obtaining color performance that will make everyone jealous.

Once you get the hang of the color convergence controls you can do a color touch-up alignment in about 15 minutes. Do one every six months and you'll maintain *great* color reception.

The user's color adjustments are really the heart of the GR-681's performance. Using only the built-in dot generator—the only test



Tuning meter built into wireless control makes for easy adjustment. You simply press transmitter button and adjust coil for maximum meter reading.

equipment needed for any adjustment—you very quickly become expert at adjusting color convergence. Color loses its *mystique*, becoming just another box with controls. At any time you are sufficiently competent and confident to reach in back of the set to make a fine color correction or convergence adjustment.

Of course, because of the multitude of controls common to color TV, the question arises, "Isn't it difficult for a newcomer with no experience in color to get a good color picture?" The answer is *no*, due entirely to the excellent manual. Before anything is touched all controls are preset as described in the manual. When power is first applied you have something on the screen and are, in fact, well inside the ball park.

Construction of the color chassis was strictly "no sweat." It worked as soon as we applied power. Our only problem was that the tuner conked out after 15 minutes operation. But from the rather good, color-illustrated service manual, we were able to isolate the trouble. (The tuner was later replaced under Heath's liberal replacement policy.)

Performance. As we said previously, the color reception is great—*magnificent*, if you prefer that term. The set is rock stable, and is less sensitive to interference than a good quality b&w set we used for comparison. Both H and V circuits locked up hard, and at no time since the set was first turned *on* have we had vertical roll or horizontal breakout.

The convergence panel, as we mentioned earlier, swings down to let you make adjustments from in front of the screen. It also contains the vertical, AGC, color-killer, sync, and dot-generator controls.

An adjustable color killer insures b&w reception that is really black and white. Even the sound is notably good. In fact, no matter how we consider the GR-681, great color reception is synonymous with Heathkit.

Last, the GRA-681-6. This wireless remote control takes two or so hours to build and plugs into the color chassis after a small wiring harness is added (and this harness should have been made part of the original assembly). It is an ultrasonic receiver that responds to six ultrasound frequencies generated in a battery-powered, hand-sized transmitter. Each frequency determines a particular function or functions. Four frequencies determine the rotation of the tint and color controls; the fifth frequency switches channels; the sixth frequency controls the receiver's sound level and power.

The remote receiver has a built-in tuning meter for alignment of each channel. Total alignment time is five minutes or less; you simply peak six coils, in turn, for maximum meter indication when the matching transmitter button is depressed.

Summing Up. As we said, if you want a great color TV set, you *have to* build a Heathkit.

Price, as mentioned before, is $500.00, and for additional information write to Heath Co., Dept. 139-68, Benton Harbor, Mich. 49022. ■

JOB HUNTING THE 1130 WAY

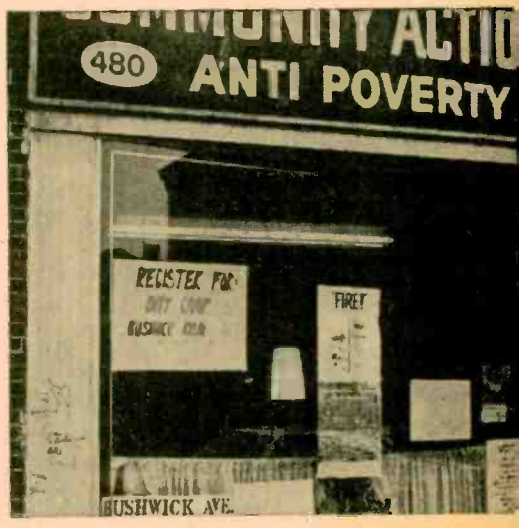
Applicant is interviewed by counselor in neighborhood employment center. Information obtained is later fed to IBM 1130 computer.

In an age when problems caused by overpopulation are more acute than ever, the major role that computers play in solving these problems can hardly be overestimated.

Typical is ways the computer enters into the areas of unemployment and *under*-employment. For example, now local or neighborhood employment agencies and social services can get in touch with a central employment agency service that gathers data on job opportunities from around the country and matches them up with their local clients. The neighborhood employment agency is linked electronically by a keypunch system that feeds all the qualifications of the client into a computer at the central agency. The computer, in turn, sends back all information about jobs and training opportunities or other data that the client needs.

Within seconds information that includes duties, salaries, location, requirements, starting date, name of employer, and all other employment information is available. The central computer also automatically demands verification from time to time of all jobs filled or not filled. In this way the computer's memory bank is kept up to date, and precious weeks of waiting and writing are eliminated.

Information on jobs is supplied to the central agency by various state and



Brain of IBM 1130 computer at agency's data-processing center. Machine searches its memory bank, supplies information in seconds.

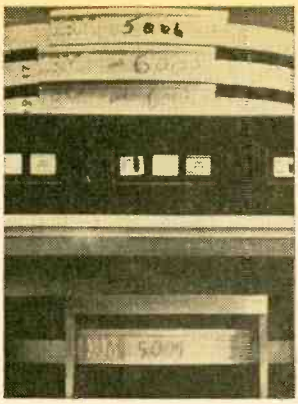
private organizations along with individual employers who are looking for specialists in various fields. An applicant at the local employment agency may choose up to three occupational code numbers, covering such jobs as receptionist, bookkeeper, typist, clerk, claims adjuster, mail clerk, bank clerk, nurse, truck driver, carpenter, painter, and welder, to name only a few. These code numbers are used to trigger the computer's memory bank that has previously recorded data on job openings.

Information sent back from the central agency supplies the local employment center's client with the necessary information that he needed. Nor does the system stop here. For having found the unemployed person a job, it also follows up on an applicant's progress after placement and training.

Our photos show several of the steps involved in matching available applicants with available jobs in the Greater New York area. Basis of the entire operation is an IBM 1130 computer, which explains why we call the process job-hunting the 1130 way.

A tongue-in-cheek conclusion: No longer does the pessimistic Malthusian theory of the need of war and famine for overpopulation hold meaning as long as the machine and especially the computer come to the rescue

—*C. Hansen* ■



Above, right, applicant takes test to determine aptitude in math and English. When tests are completed, findings are coded, then speeded to 1130 computer (below). Numbers are key to operation; computer deals in numbers, not names.

Below, left, neighborhood employment agency in poverty area is in constant contact with main computer center. Local businessmen are told of computer's employee-finding potential (center); counselor instructs job applicants (right).

Here's a job you can keep! A U.S. Steel technician removes a latent charge from a 17-ft. high accelerator, part of a million-volt electron microscope. But don't worry about him being zapped. After unit is fired, almost all of the charge is used up—efficiency is good!

1000-kV Peek-a-Boo

Scientists at United States Steel's Fundamental Research Laboratory soon will take a penetrating look into the unknown and unseen secrets of the moon. To do so, they'll bombard lunar specimens with a stream of electrons on the nation's most powerful electron microscope.

The million-volt super tool, located at Monroeville, Pa., is key instrument in an unique collaborative study of lunar surface material. The National Aeronautics and Space Administration has contracted for the study with U.S. Steel; Case Western Reserve University, Cleveland; and the University of California, Los Angeles.

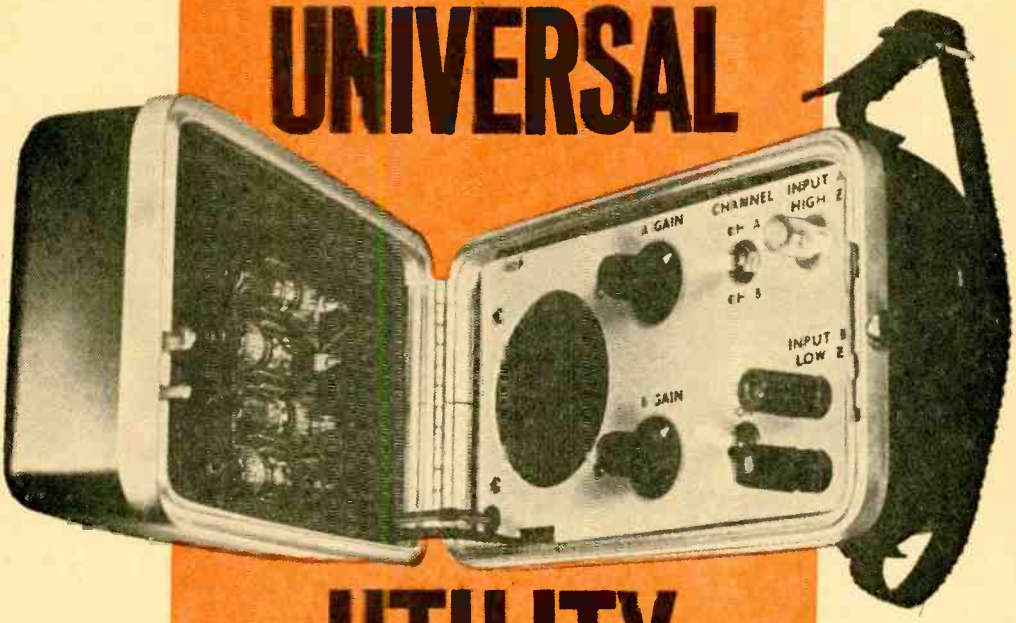
Arranged by Professor S. V. Radcliffe of Case, the cooperative investigation will combine the efforts of experts in several scientific disciplines in order to ensure its complete success. Experts in petrographic analysis, headed by Professor D. T. Griggs of U.C.-L.A., will select samples of greatest interest for study which will then be prepared for transmission electron microscopy by Professor A. H. Heuer at Case.

Unlike conventional microscopes, the unique instrument has the capability of looking completely through a specimen with its electron beam and not just at a magnification of its surface. Scientists are eagerly anticipating the opportunity of examining the entire depth of thicker-than-normal specimens of the lunar material. The scientific value of thicker specimens is that they are more truly representative of the natural state of the material; they are easier to prepare and far more accurate appraisals can be made from them.

To attain its vast power, the microscope uses a million-volt accelerator. Though the accelerator stands 17 feet high and weighs 15 tons, its precision stabilization system maintains the DC voltage constant to within 0.0004 percent. An accelerated stream of electrons is fired through the microscope's magnetic lenses at approximately 94 percent of the speed of light. This velocity gives the electrons a penetrating power of up to ten times that of beams used in standard electron microscopes and makes it possible to examine much thicker specimens. ■

COVER STORY

UNIVERSAL UTILITY AMPLIFIER



Only one IC, but you can get up to better than a watt output

by Ed Morris, W2VLU

HOW MANY TIMES have you been frustrated because you had to make do with a compromise item in an experiment because you didn't have the one that was called for? You undoubtedly know what we mean. You saw an article describing an experiment you would like to try that depended on a small amplifier. So you had to improvise by borrowing (?) the youngster's phono or your wife's transistor radio. End result was that you wound up with Excedrin headache no. 279 and became an expert at defining frustration.

Seriously, most experienced servicemen and experimenters are well aware of the true value of a good universal utility amplifier for test purposes. Many, in fact, keep one on hand for just such applications. The neophyte, however, may not realize how handy, and at times absolutely necessary, such a unit can be. Therefore, for the relative newcomer in electronics, here

are the details on how to build a top-notch utility amplifier for the embryo test bench. Also, building this up-to-date, solid-state Universal Utility Amplifier, should give any old pro excuse enough to retire his older, vacuum-tube versions.

Reasonable Power at Low Cost. Our utility amplifier can be built for just about $15.00, and that is based on having to buy all new components. When using the self-contained battery pack of four inexpensive AA cells, it delivers audio power in excess of 300 milliwatts. This same basic unit can be modified to provide a maximum power output of one watt, but more on that later.

The integrated circuit (IC) we used has fairly high sensitivity. When operated as a class B amplifier, with just 35 millivolts input, an output of about 150 milliwatts can be developed when using a 3-volt supply, or 400 milliwatts when using a 6-volt supply. If a CA3020A is substituted for the CA3020 we used, an output of slightly more than one watt is available when a 12-volt supply powers the unit.

The amplifier has both high- and low-impedance inputs that are switch-selectable from the front panel. The high input has an impedance of 55,000 ohms, while the low input impedance is 1000 ohms.

With just a few hand tools you can easily build our IC utility amplifier in three to five hours. Considering its small size and portability in contrast to its large performance, it's an extremely useful, versatile, and handy piece of equipment to have on the bench.

How It Works. An RCA integrated circuit is the basic component of the complete amplifier. Both the CA3020 and CA3020A are multifunction, low-cost, wide-band ICs that can be used as power amplifiers and drivers in portable and fixed communications equipment. They are designed to operate from a single supply voltage which may be as low as 3 volts. The maximum supply voltage is dependent on type of circuit operational requirements.

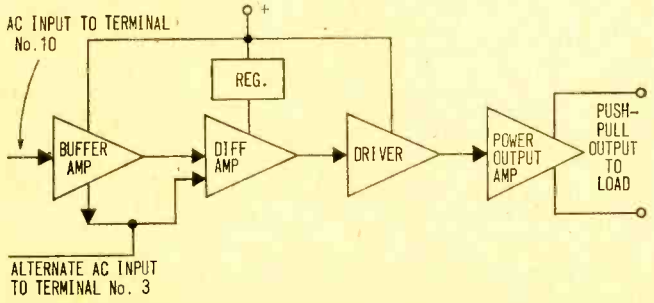
As used in the Utility Amplifier, the IC comprises the total complete amplifier assembly without requiring any other transistors or diodes. It serves as buffer, phase inverter, driver, power amplifier, and voltage regulator—and all in that little metal container. A few additional external components are required to couple audio signals and to set the operating conditions for the internal circuitry of the IC.

A functional block diagram (below) of the IC, indicates the relationship of its various sections. The voltage regulator is of basic importance in its operation. It provides accurately controlled voltages to the differential amplifier so that the proper idling current for the class-B operation is effected in the output stage. The differential amplifier operates in a class-A mode to provide required gain and phase inversion for the class-B driver and output stages.

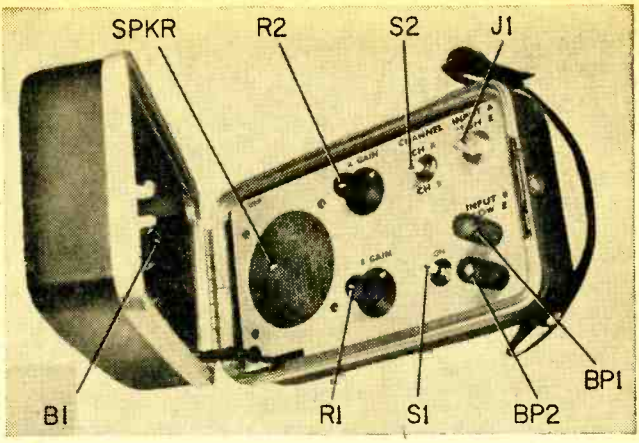
The drivers are emitter followers which shift voltage levels between collectors of the differential amplifier transistors and the bases of the output transistors. They also provide the drive needed by the output transistors. The output-stage transistors are large, high-current devices and are able to deliver peak currents better than 250 mA. The emitters of the output transistors are brought out to pins 5 and 6 so that more complete stabilization of the idling current of the amplifier can be effected.

By adding resistors externally between pins 5 and 6 to ground, effectiveness of internal DC feedback supplied to the bases of the differential amplifier is enhanced.

To visualize the operation of this "mighty-mite" package, let's trace a signal from the input jack of our amplifier to the output through its self-contained speaker. Audio



Function block diagram for CA3020/CA3020A ICs shows relation of voltage regulator to differential amplifier and indicates signal flow through IC. CA3020 and CA3020A are identical except for power output; CA3020A accepts higher voltage and produces greater output.

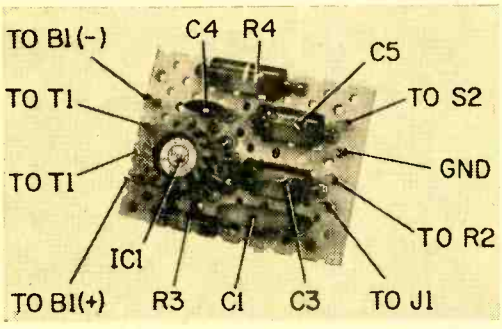


Carrying case opened, showing location of batteries. Three AA cells mount in clips in cover to clear controls.

signals, fed in through the high-impedance input (J1), are coupled via C1 to the input of the buffer amplifier. (C1 also blocks buffer-amplifier DC from the input of differential amplifier.) Output of this stage (pin 1) is coupled to the input of the differential amplifier (pin 3) through the gain control (R2) and capacitor C3. Resistor R3 establishes the operating conditions of this stage.

When input channel selector switch S2 is in *Chan A* position, the high-impedance input is selected. When S2 is placed in *Chan B* position, audio signals fed in through low-impedance input terminals BP1 and BP2 are coupled through R1, which serves as gain control for low-impedance input, to C3. They are then fed to pin 3, the input connection to the differential amplifier.

Because of the extended frequency range of the CA3020/CA3020A ICs, capacitor C4, a high-frequency AC bypass capacitor, is connected to pin 3 to prevent oscillation at



Amplifier circuit card detailing location of components. Wiring on underside of board can be hard wired or etched foil.

stray resonant frequencies of the external components, especially the output transformer. Pin 2, the other input to the differential amplifier, is placed at AC ground potential by capacitor C5.

Output of the differential amplifier is internally connected to the driver and from the driver to the output transistors in the output section of the IC. The output signal appears at pins 4 and 7, where it is coupled to the speaker through transformer T1, which matches collector-to-collector impedance of the output stage of the IC to the voice coil of the speaker. As previously discussed, R3 stabilizes the push-pull power stage.

Mechanical Construction. For greater versatility and applicability, we made our amplifier assembly portable. The Kodak M2/M4 camera case that we selected to mount our Utility Amplifier in serves very well as a housing for the unit. This lightweight, foam-padded interior, rigid body case makes an ideal housing for many small electronic instruments. We purchased ours from the photographic section of a local department store for less than $5.00.

Start the mechanical construction by mounting the battery holder in the upper half of the case, close to the hinge. It should be located so as not to interfere with switches and controls, etc., when the case is closed. A red paint marker (use some of your best girl's nail polish) on each of the battery clips near the positive end will ensure that the batteries are properly inserted.

Front Panel. The front panel is a 3½ x 6½-in. piece of G-10 grade, epoxy-glass printed circuit board. The copper-clad side is used as chassis ground. Epoxy glass sheet can be easily cut and drilled with simple hand tools.

Layout and drill all of the holes for the components that are mounted directly on the panel. The large hole for the speaker can be cut easily with a hand nibbler. An alternate method to make the speaker opening and grille would be to drill a series of closely spaced holes in a pattern similar to the perforated metal grille we used in our model.

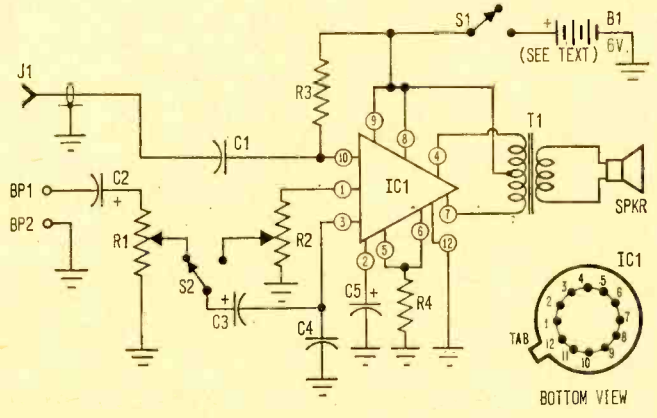
Thoroughly clean the copper side of the

board after all the drilling has been completed. Either copper cleaner or an abrasive cleaner such as Comet can be used. This prepares the surface for easy soldering. Gently sand the epoxy side of the board with a medium-fine grade sandpaper to condition the surface for painting.

Wash the board and thoroughly dry it before painting. Follow manufacturer's directions for applying the spray paint. When spray-painting it's best to apply several light coats of paint instead of a single heavy coat. Be sure to allow each coat to dry completely before applying the next. For a really professional job, "*fog*" on the first few coats, and follow this up with an additional 3 to 5 light shiny coats. The results are well worth the extra work.

Add a finishing touch to the front panel by applying dry-transfer letters or decals. If you use dry-transfer letters allow the final coat to harden overnight before applying the characters. This will prevent the possibility of a slightly tacky finish from adhering to the letters on the transfer sheet. Apply a clear acrylic spray as a finish coat to protect the lettering from abrasion. Be sure the first coat of acrylic is very light, since excess solvent in a heavy coat could dissolve the transfer letters or decals.

Electrical Construction. Although the layout of the amplifier isn't critical, consideration should be given to the high gain and wide bandwidth of the IC. It will oscillate if there is sufficient coupling between the input and output circuits due to stray wiring capacitance. The newcomer would be wise to follow our layout. The more experienced experimenter may want to modify the layout to best suit his needs. In any event, good



PARTS LIST FOR UNIVERSAL UTILITY AMPLIFIER

B1—6 volt battery 4-AA 1.5-V alkaline cell batteries (Lafayette 99T6294 or equiv.) (see text)
BP1—Red binding post (Lafayette 99T6121 or equiv.)
BP2—Black binding post (Lafayette 99T6120 or equiv.)
C1—0.1-uF, 75-V ceramic disc capacitor (Lafayette 99T6069 or equiv.)
C2—15-uF, 25-V electrolytic capacitor (Lafayette 34T8459 or equiv.)
C3, C5—6-uF, 25-V electrolytic capacitor (Lafayette 99T6054 or equiv.)
C4—0.01-uF, 75-V ceramic disc capacitor (Lafayette 33T6905 or equiv.)
IC1—RCA type CA3020 (see text)
J1—BNC chassis mounting connector (Lafayette 32T2122 or equiv.)
R1, R2—5000-ohm potentiometer, audio taper (Lafayette 33T1121 or equiv.)
R3—510,000-ohm, ½-watt resistor
R4—0.56-ohm, 2-watt resistor
S1, S2—Dpdt miniature toggle switch (Lafayette 99T6162 or equiv.)
Spkr—2½-in., 10-ohm speaker (Lafayette 99T6097 or equiv.)
T1—Output transformer; 125-ohm CT pri., 8-ohm sec. (Lafayette 33T8571 or equiv.)
1—Battery holder for type AA cells (Lafayette 34T5009 or equiv.) (see text)
1—Carrying case (Kodak M2/M4 camera case or equiv.)
1—3½ x 6½-in. G-10 epoxy glass printed circuit board (cut from Lafayette 19T3704 sheet or equiv.)
1—1.3 x 1.9-in. piece perf board (cut from Lafayette 19T3606 or equiv.)
1—Heat sink for IC (Wakefield NF-209 or equiv.)

Misc.—Spray paint, sandpaper, bolts, nuts, wire, solder, hand tools, dry transfer letters or decals, push-in terminals, etc.

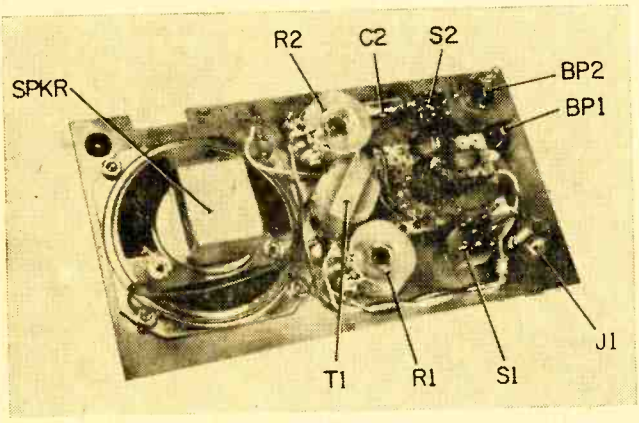
practices for high-frequency wiring should be followed. 'Nough said?

Mount the potentiometers, switches, and input terminals and jack on the front panel which is detailed in our photo. The speaker is mounted with machine screws. A 2½-in. square piece of perforated aluminum is mounted between the speaker and the front panel to serve as a grille, unless you drill your own grille directly in the epoxy glass board as mentioned earlier.

Transformer T1 is mounted as shown in our photo by soldering its mounting tabs to the copper side of the board. Clean the tabs so that the solder will flow evenly on them.

Perform the soldering quickly, using a medium-powered soldering iron (50-100 watts). Remember, too much heat will blister the paint on the reverse side of the board.

Next, mount the balance of the components on a 1.3 x 1.9-in. piece of perf board as shown in our photo on page 65. All



Rear view of front panel locating controls, speaker, and circuit board on which IC and its components are mounted. Front panel is spray painted and marked with transfer letters.

of the remaining components with the exception of C2 are mounted on this card. Capacitor C2 is self-supported between gain control R1 and BP1 by its leads.

Though we built the amplifier on a perf board, an interesting variation would be to construct it using a printed circuit technique. The September/October '69 issue of ELEMENTARY ELECTRONICS contains an article that details construction of a printed circuit board which can be used as a guide to technique for making this one. Push-in clips are used to mount components to the board and as terminal points.

Use a battery clip as a heat sink when soldering the IC circuit leads. A well-tinned, low-powered soldering iron (20-50 watts) should be used for this operation. Complete the soldering as quickly as possible to avoid too much heat—this could damage the IC.

After the various components have been positioned on the card and wiring links have been made between them, check for errors in circuitry before soldering connections. Also, check that electrolytic capacitors have been properly polarized, that there are no shorts, and that the wiring to the IC is correct, thus avoiding having to replace components. Once they're soldered it's hard to remove them, especially ICs.

The completed card is mounted on the rear of the front panel, as shown in Fig. 3. We used ¼-in. squares of plastic, cemented to the panel as stand-offs and then cemented the circuit card to them. We used this method, rather than screws, which would interfere with the lettering on the operating side of the front panel. Now connect the mounted circuit card to the controls and other components on the panel Capacitor C2 is wired in at this time. Use very flexible stranded test lead wire for leads from the battery holder to the amplifier.

Check the completed assembly for possible shorts, cold solder joints, etc. Insert the batteries in the holder, making certain that polarity of each of the cells is correct, and you are ready to test the unit. Connect the input to an audio oscillator (if none is available, a microphone will do, or the output from a tuner). Turn the amplifier *on*, and if all is well you should hear "beautiful music!" Be sure to check both high and low inputs.

If only one input works, check the input circuit for the channel that doesn't work. Make corrections to wiring or replace any defective parts. If neither of the inputs operate, first check for battery polarity, then for cold solder joints, or for possible short circuits that may have developed when the panel was inserted while mounting the assembly in the case.

This done, check the wiring once again. If all these tests reveal no errors, check all the external components connected to the IC with an ohmmeter to be sure of their correct value. If all checks prove OK and the circuit

wiring is correct in every respect you will have to replace the IC.

Higher Output Power. As mentioned earlier, should you prefer more than the 300 milliwatts output power, the power of our basic amplifier, you can raise it to 550 milliwatts or even 1 watt very simply. To raise output to 550 milliwatts, all that's required is to increase the battery voltage from 6 to 9 volts. This can be done by substituting a standard 9-V transistor radio battery for the four AA cells.

It's possible to achieve the 1-watt-or-better output by using a CA3020A IC in place of the CA3020 and raising the battery voltage to 12 volts. Do this by doubling up on the AA cells, using 8 rather than 4 (you will need an additional battery holder to do this). The CA3020A has a higher voltage rating than the CA3020. This permits using 12-V supply instead of 9, the maximum for the CA3020 in push-pull class B operation. It's the higher voltage that provides the increase in output power. The CA3020A has the same pin connections as the CA3020 and can be placed in the circuit without having to change any of the wiring.

A word of caution: if you elect to make your Utility Amplifier with the higher output be sure that the speaker and output transformer you use in the output circuit can handle this much power. We suggest that in the event you go to the higher output, you bring out the output leads through a suitable jack or binding posts on the front panel. The output leads are connected to pins 4 and 7 of the CA3020A.

Now that you've assembled this easy-to-build, simple, useful, and inexpensive portable Utility Amplifier, we're certain you have thought of its many potential applications. Some of the uses that come to mind immediately are the audio amplifier of a phonograph; a low-powered stereo amplifier (using two of the amplifier assemblies); the modulator section of a low-powered amateur transmitter; or, as an amplifier in intercom systems. No doubt you can dream up other applications. ■

the big push IN *read* OUT

Stock transactions will take place at some of the fastest rates in history once automated quote boards are installed on the Amex Trading Floor. Above, Frank C. Graham, Jr. (left) and James J. Maguire of Amex discuss automated quote board.

A.B. Dick Co. officials predict print-out bottlenecks in computer data transmission networks will soon be a thing of the past. Reason: the company's new Videojet 960 printer, which employs an electronically controlled stream of ink droplets to print 3000 words a minute—15 times the rate of printers now in use.

e/e PRODUCT TEST

KNIGHT-KIT MODEL KG-392
Electronic Rhythm Section
Combo Sideman

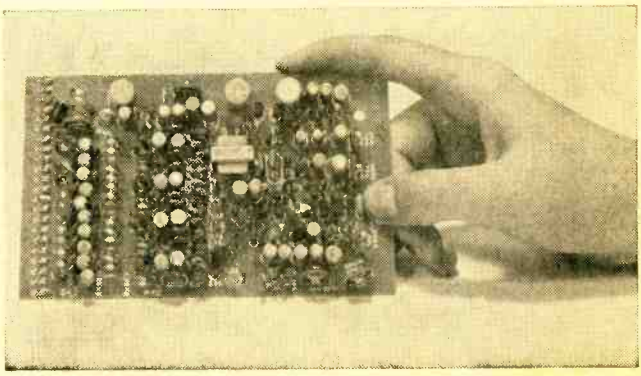
Among the things that are more fun doing with someone else is music. While it may be fun to play alone, it's a lot more pleasure if you're part of a crowd. But if you can't rustle up a rhythm section for some practice, you can do the next best thing by creating your own aggregation with *Knight-Kit's Combo Sideman.*

An electronic device that synthesizes a drummer with bass drum, snare, and high-hat cymbal, the Knight-Kit KG-392 Sideman consists of a rather flat metal enclosure having rubber feet. It provides six switch-selected rhythms tailored primarily for modern music (no waltzes!). The six rhythms are shown in the accompanying chart. A second control determines the rhythm's tempo, while a third control establishes the volume level. Internal trimmer potentiometers allow the user to shift the overall range of the tempo and volume controls to suit personal preference.

A pushbutton switch provides for start/stop (*on* and *off*), while a second pushbutton labeled *solo* provides a continuous "drum roll" as long as the button is held down. Three phone jacks provide the signal output, *on/off* footswitch control, and footswitch control of the *solo* effect. Supplied with one pre-wired output cable and one footswitch that can be used for either *on/off* or *solo,* the unit is powered by a transistor radio type 9-volt battery. A handy clip inside the cabinet retains a spare battery.

A Look at the Circuit. The sounds created by the Sideman are actually shaped and frequency-equalized noise—the same technique as used in all other rhythm generators regardless of price. The bass drum effect is a voltage-keyed oscillator. A single transistor is biased almost to the point of oscillation. When a voltage pulse is applied to the base circuit, the oscillator is "kicked on" by the pulse and then decays relatively slowly as the oscillations die out.

A three-stage transistor circuit generates "white noise" for the snare and cymbal effect. The noise is fed to a tuned amplifier which is held at cut-off. When a voltage pulse is fed to the base of the transistor amplifier, the amplifier is turned *on.* The noise signal is then passed through the tun-



The circuit board for the Knight-Kit Combo Sideman is jam packed with oscillator and multivibrator circuits. Be sure you handle this board with care to avoid damaging the components. Just imagine building this kit from scratch as a construction project—it'd never get done.

ing circuit which shapes the noise frequencies to sound like a snare of high-hat cymbal, depending on the degree of decay. The voltage level of the applied triggering pulse determines the amplifier's output level and decay rate, which is differentiated by the listener's ear as a snare or cymbal.

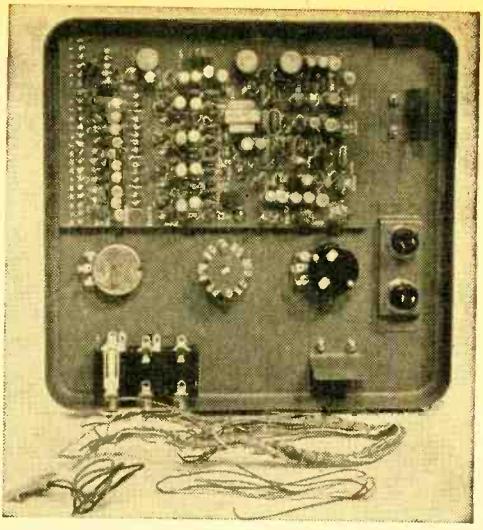
Five Multivibrators. The rhythm is detemined by a "clock" multivibrator and four multivibrator frequency dividers. The clock multivibrator (MV) provides what can be called sixteenth notes. The clock's output feeds a MV frequency divider which generates square-waveform eighth notes. Depending on which of the MV collectors the divided signal is taken from, the MV output "starts" either on the first 1/16 or on the second 1/16. The same thing is done through three more dividers so that at the final MV the output pulse is equal to a whole note.

The assorted MV outputs are then combined through the *rhythm* switch to provide the desired rhythm. For example, in Position B the first MV divider provides 1/8-note high-hat effect, while the 1/4 note triggering provides the bass drum and snare on every second high-hat beat.

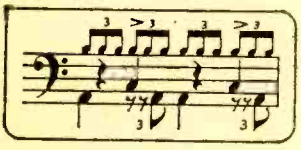
Since the effects are triggered by the leading edge of the MV waveforms, the MV outputs really provide the delay necessary for keying in the appropriate effect at the right time. In the Position B illustration, the rhythm selects the 1/8-note MV output to key in the high-hat cymbal. The snare and bass effects are keyed by the MV divider following the 1/8 divider, so they are keyed in on every second beat. When we get to Position E, which is somewhat complex, feedback is thrown into one MV divider to produce an "unnatural" time delay of approximately 1/64. While the idea is somewhat complex, the actual circuitry is not.

The outputs from the three effects circuits are combined in a preamplifier and fed through a volume control(s) to the output jack. The output level is more than sufficient for all instrument amplifier inputs, and will be adequate for some extra-sensitive hi-fi amplifier auxiliary inputs.

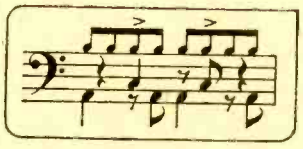
(Continued on page 100)



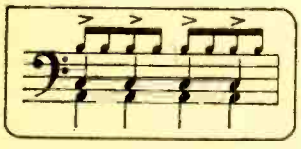
Wide parts layout combined with preformed wiring harness totals up to 45 minutes of assembly time. Troubleshooting is easy because you see everything.



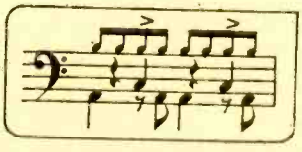
Position A



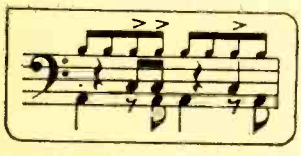
Position D



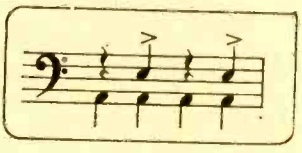
Position B



Position E



Position C



Position F

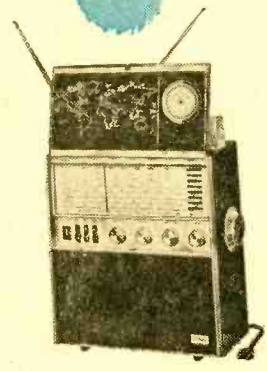
Just in case you're not a boob like the Editor, here are the rhythms generated by the Knight-Kit KG-392. If you can read music, start humming; otherwise, listen and enjoy as we boobs do!

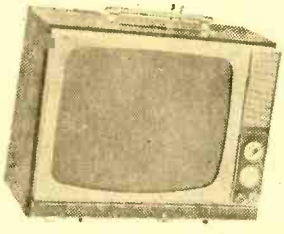
what makes SUPERHETS so SUPER

by Len Buckwalter, K1ODH

The road to radio reception is littered with circuits that electrified the world, had a flash of greatness, then faded in the zenith (and RCA, too). One of the first was the Branly detector—merely a glass tube filled with metal filings that clung together when they picked up a radio wave. This was vastly improved by Marconi who added a clapper to strike the glass and shake loose the filings. Now the receiver could respond to Morse code. Soon there was the cat's whisker, the TRF (tuned radio frequency) and regenerative receivers. But today these circuits are practically museum pieces except for SWL receiver projects in this magazine.

All were short-circuited by Major Edwin Armstrong's World War I development of the *superheterodyne* receiver. You can measure its success by counting the superhets you probably now own. It's the standard in the TV set, FM radio, transistor portable, car receiver and table radio. If you're a ham, CBer, SWL or radio-control fan, chances are your receiver is a superhet. The same is true if you run a radar, loran, aircraft navcom or just about any receiver that picks up radio signals and turns them into audio, video or needle indications. Why is it so super?





Wide as a Barn Door. It goes back to quirks in the receivers' tuning circuits, mainly the variable capacitor-and-coil combination. These components, hopefully, select one frequency from many (in the antenna, for example) and slice away undesired signals. How well any tuning circuit can isolate frequencies is a measure of *selectivity*. Simple tuning circuits suffer poor selectivity for at least three reasons: unfavorable tuning ratios; resistance introduced by the coil; and operation at high frequencies.

An example of the first problem—tuning ratio—is apparent in the photo of Fig. 1. It's the dial of a cheap transistor radio. Notice how the numbers are spaced. Between 6 and 7 (600 and 700 kHz) there's about one-quarter inch; and from 11 to 16 there's also a quarter-inch span. Signals in the upper end of the band, therefore, are apparently compressed. How does dial crowding occur? The reason is in the tuning rate of the variable capacitor in relation to its companion coil (Fig. 2). At the high end, the tuning rate, or speed, of the variable capacitor becomes relatively faster than for the low end of the band. Thus, for a given amount of dial twisting, more stations whiz by at the upper end. There are technical solutions to the problem. There's permeability (coil) tuning (done in a car radio), band-switching

the coil (in expensive receivers) or selecting whole tuning circuits for each frequency (done in TV tuners). But these remedies are costly, only partly effective, or both.

The second big problem—resistance—also lowers tuning efficiency at the higher end of a band. Any tuning circuit resonates to a frequency by virtue of an LC ratio; there's a given amount of coil inductance (L) to capacitance (C). A signal on a particular frequency may be tuned either by a large capacitor and small inductance—or vice-versa. But here's the flaw. If a circuit uses a relatively high inductance (more L than C), efficiency is poor. It's because the resistance of the coil becomes a major value in circuit operation. Resistance not only causes a broadening of the circuit's selectivity, but a drop in signal voltage. (See actual scope tracing in Figs. 3A and B.) You'll notice it when you tune a table radio to the high end of the band—unmeshed capacitor plates mean low capacity, high inductance, and usually poorer reception.

The Gang's All Here. Radiomakers in the 1920s fought these problems by piling tuning circuits into the "tuned-radio-frequency" receiver. Old radio catalogs advertised the "4-gang TRF" that boasted of reception without man-made interference (meaning other stations on nearby frequencies). The set had a line-up of four radio-frequency amplifiers simultaneously tuned by a 4-gang variable capacitor. Adding more tuned circuits could certainly improve selectivity and gain, but another obstacle stood in the way. It's the third major problem of tuned circuits, which is operation at high frequency.

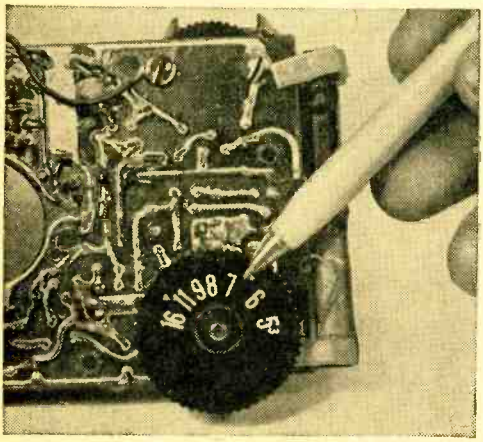


Fig. 1. Nobody notices the odd spacing of the typical low-cost superhet until they try to locate a station at the high end of the dial. Blame this on the capacitor's tuning rate, not the superhet.

Broadcasters and communicators were reaching for ever-higher frequencies where tuned circuits alone couldn't provide adequate selectivity to pick apart two close-spaced signals. It's an electronic fact that as frequency rises, the response of a tuning circuit retains the same proportions, or response curve, but appears relatively wider to a signal of fixed width. This is illustrated in Fig. 4. A voice signal 8-kHz wide is easily selected by the tuning circuit at a low frequency, while the same signal wallows in

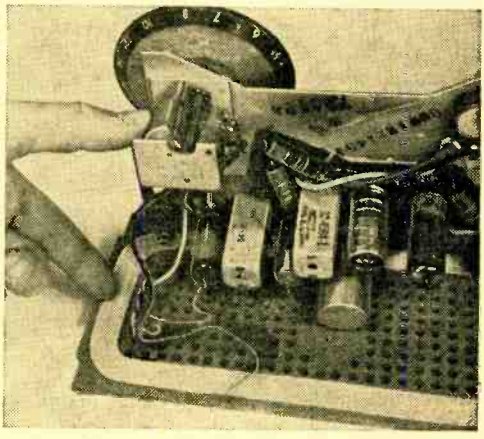
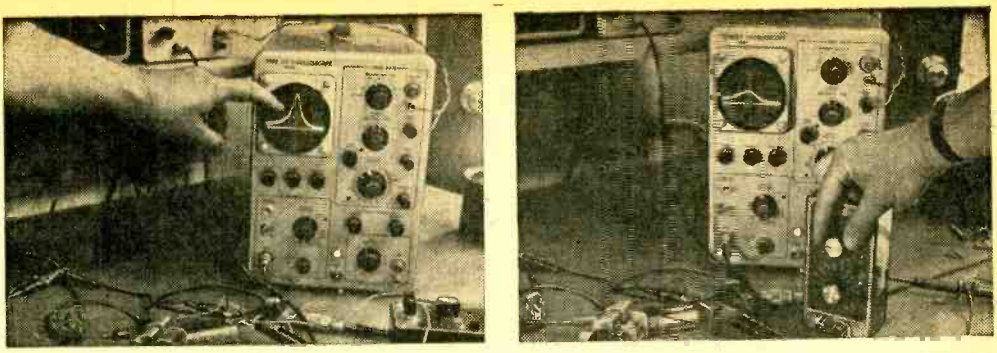


Fig. 2. Tuning circuit consists of variable capacitor (under thumb) and antenna coil (under finger). Tuning is lousy at high end of the dial.

the wider gap of the higher tuning circuit. Everything about the two circuits is the same—efficiency and LC ratio—only tuning frequency is different. Yet the higher-frequency circuit allows a garble of signals to enter the receiver.

Job for Super-Man. Then came the concept that touched off the revolution. If higher frequencies and variable tuning cause trouble, why not get rid of them? That's the secret of the superheterodyne. First, incoming antenna signals are juggled downward in frequency. Then, tuning circuits can operate on them with high selectivity and sensitivity. As we'll see, the superhet's amplifiers will be mainly *fixed*-tuned, so energy-robbing tuning ratios can be avoided. To see how the idea operates, first pick apart the word itself.

The prefix "super" is short for "super-



Scope photos show effect of introducing resistance in a tuned circuit. Curve at left (Fig. 3A) shows good selectivity. Note how narrow the "spike" is at top. Fig. 3B (right) shows same circuit setup except that resistance added to circuit broadens curve.

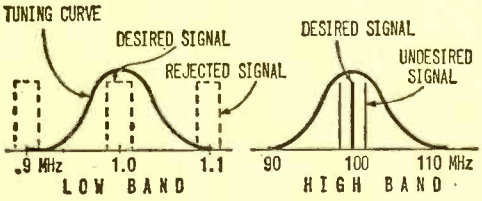


Fig. 4. Low- and high-band response curves have same shape. Selectivity, though, is poorer on high band because signals appear closer together.

sonic." It refers to a new signal born within the superhet. It's dubbed supersonic because it's lower in frequency than a radio signal, but higher than an audio frequency. "Heterodyne" literally means "different forces." In the superhet it refers to a technique that mixes two different frequencies to generate a third one. From this brew will emerge the three most important frequencies (Fig. 5) for comprehending the superhet:

RF or Radio Frequency. This is the original signal from the station. It's picked out of the air by the antenna, and selected by the first receiver stage. But it won't remain a high frequency for long.

IF. This is the "supersonic" signal. Since the term supersonic is too aeronautic, not sufficiently electronic, it's referred to as the

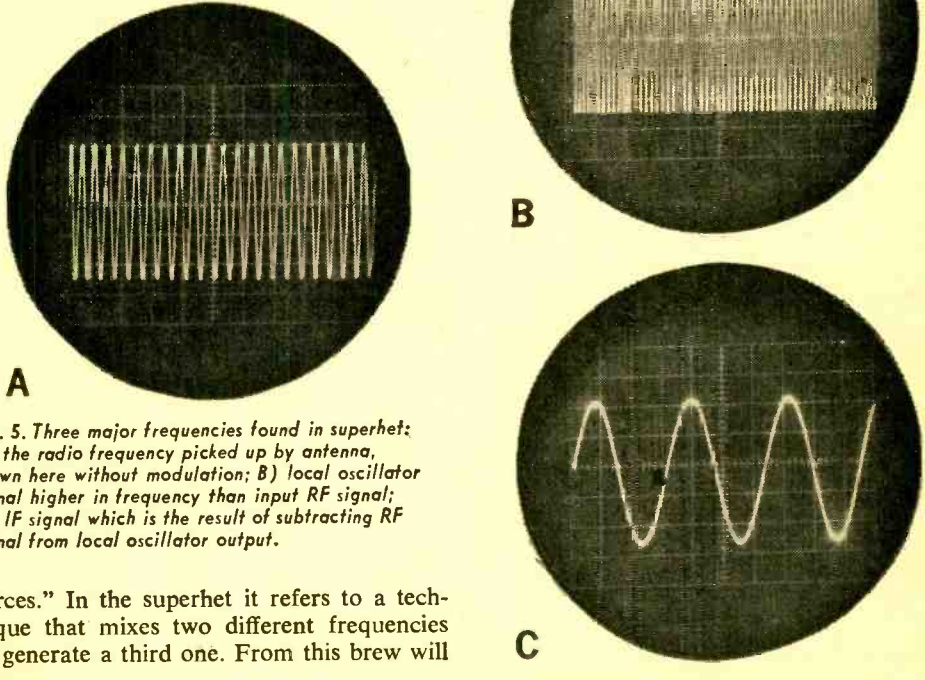


Fig. 5. Three major frequencies found in superhet: A) the radio frequency picked up by antenna, shown here without modulation; B) local oscillator signal higher in frequency than input RF signal; C) IF signal which is the result of subtracting RF signal from local oscillator output.

"intermediate frequency," or simply IF. This is the desirable low frequency that all RF signals must become.

Local Oscillator. This is the circuit that creates the third essential superhet signal, the local oscillator frequency. It's a generator within the receiver to produce a *steady* (unmodulated) signal.

With these three signals, we can restate the main idea behind a superhet: The incoming RF signal is mixed (heterodyned) with the local oscillator frequency to produce the IF signal on some lower (supersonic) value.

There's a musical analogy for the process: Strike adjacent notes on a piano and there's a "sour" sound. It's because the original tones mix and produce a third one, or "beat" tone that imparts the dissonant sound. The beat note occurs as a difference frequency between the two original notes. In the superhet, the RF signal is equivalent to one piano note, the Local Oscillator equivalent to the adjacent note. The IF signal is the beat note produced by mixing the original tones.

Enter RF. To start the process, examine the front end of the superhet shown in Fig. 6. We'll assume the radio is tuned to a broadcast station in the lower end of the band, at 710 kHz. In a typical table radio, the incoming RF signal is tuned by a variable capacitor and loopstick (or some other type of antenna coil). The signal is applied to the Mixer stage where the heterodyning process takes place. (Some people call this stage the "Converter" or the "First Detector.") Whatever the name, the stage combines the 710 kHz station with a steady signal from the Local Oscillator. That oscillator signal is on 1165 kHz. Why the odd number?

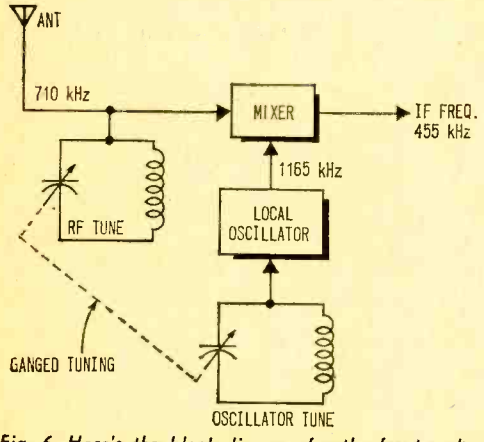


Fig. 6. Here's the block diagram for the front end of a superhet receiver. Dotted line for ganged tuning means both variables are on the same shaft.

Recall that the goal of the superhet is to convert the high RF signal to a low IF which is on a fixed frequency. The value will be 455 kHz, a standard IF frequency for home AM radio. Thus, a 710 kHz signal mixed with an oscillator signal of 1165 kHz produces the 455 kHz difference frequency. This is the result of a mixing or heterodyning action.

Tricky Tracking. Now tune the radio to 1560 kHz on the BC band. Somehow the Local Oscillator must rise to the occasion and produce 2015 kHz. Simply subtract 1560 (RF) from 2015 (Oscillator) and there's 455 again (the IF). How the Local Oscillator adjusts to each signal is done by *tracking*. The variable capacitor—the one that is manually tuned—is a two-section unit with two sets of plates on one shaft. (See Fig. 7.) One section tunes the RF signal in the antenna circuit as the other simultaneously tunes the Local Oscillator.

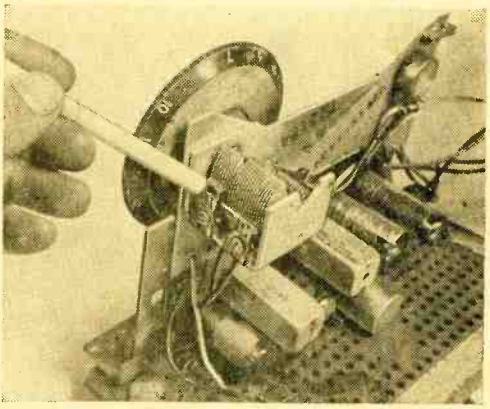


Fig. 7. Author points out the local oscillator tunable capacitor. Smaller number of plates is the tipoff. Larger capacitor tunes in radio signal.

It's akin to two runners trying to maintain a given separation. If the leader speeds up, the follower adjusts his pace to keep a constant distance. In a receiver, the local oscillator tracks the air signal to maintain a 455-kHz span. You can recognize these multiple, or gang-tuned, circuits in a schematic diagram by the dotted line between circuits, as shown in Fig. 6. As the larger section selects stations from 550 to 1700 kHz, the other section produces oscillator signals from 1005 to 2155 kHz—always

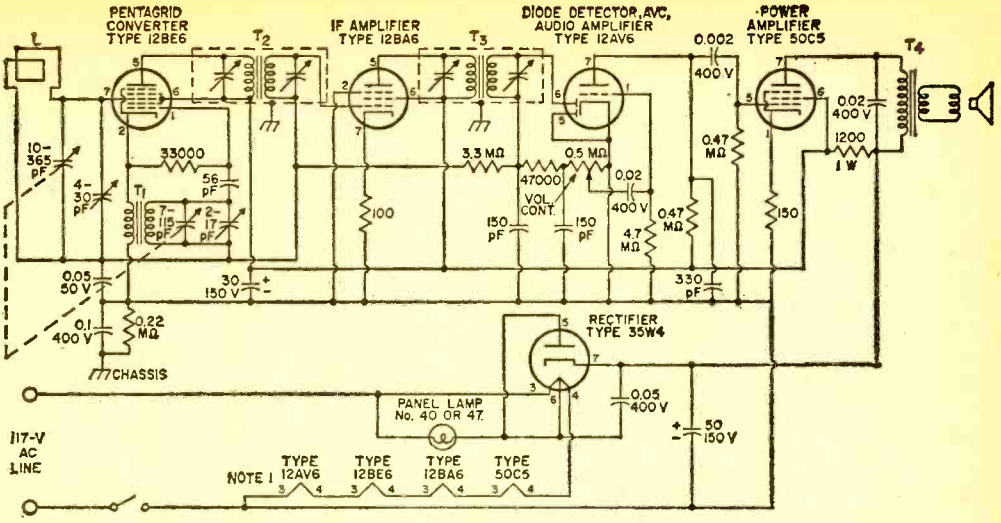


Fig. 8. Here it is! Probably the world's most produced circuit is the 5-tube superhet schematic diagram shown here. It has remained unchanged for decades. Transformers T2 and T3 are 455-kHz IF units often called "IF tins."

455 kHz above the RF value.

The Super's Heart. If the Mixer is the mathematical brains of the superhet, the IF Amplifier is its heart. For it is here that most of the receiver's extraordinary sensitivity and selectivity are created. Although an IF amplifier may consist of one to four stages, the basic benefit is the same. It is fixed-tuned to a single frequency (the IF) so there's no problem with unfavorable tuning ratios as in the old TRF circuit. And it operates at relatively low frequency where selectivity is good and amplification can be more efficient. A single-stage IF amplifier can be seen in Fig. 8.

In fact, it's possible to have too much of a good thing. The IF amplifier in a table radio, for example, is aligned by adjusting its tuned transformers to 455 kHz (Fig. 9). Unless the manufacturer used care in his design, the high sensitivity of an IF stage may trigger it into oscillation to the accompaniment of shrieks and howls. In an FM receiver, precise alignment may produce such sharp IF selectivity that quality suffers because of "side-band cutting"—a part of the signal fails to squeak through. In a TV set, IF alignment is extremely critical to preserve a balance between low and high frequencies which create large and small detail in the picture.

Second Detector and Audio. To complete the superhet, we need only add a second detector and audio stages, as shown in Fig. 8. We won't go into detail here because the stages are conventional and there's much more to be said about the superhet's special circuitry. The *second* detector (the mixer is the *first* detector) is merely a rectifier that slices away the upper or lower half of the IF signal voltage (either positive or negative portion) as the first step in the detection process. (Otherwise positive and negative halves of the IF signal would cancel each other later on.) The output of the detector is the desired audio frequency, which is boosted in the audio amplifier and finally reproduced in the speaker.

Killing the Image. The superhet is the reigning monarch among receivers, but it

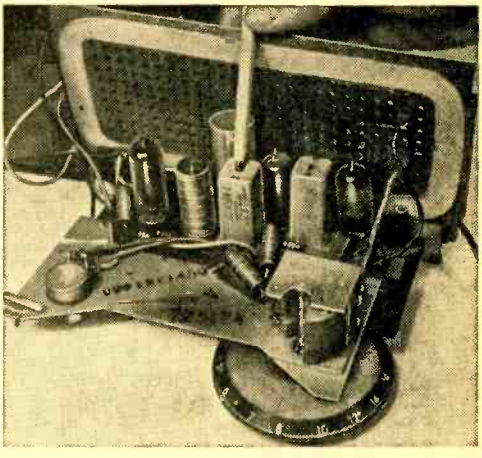


Fig. 9. Author points out IF tins—these IF coil units received their name from the galvanized-iron shield used years ago. Today, aluminum is used.

e/e SUPER SUPERHET

also suffers from certain electronic faults. A major one is *images,* ghostly interference which springs from a superhet's basic operation. We've seen that an IF amplifier is poised, ready to grab and amplify any signal on 455 kHz. The problem is that for any given setting of the tuning dial there are *two* possibilities for creating 455 kHz.

For example, if the set is tuned to 1600 kHz, the Local Oscillator will match it with 2055 kHz, so the 455-kHz difference is produced. But a dangerous possibility exists if there's also a station on 2510 kHz in the vicinity. Like the desired signal it can mix with the oscillator to produce 455 kHz (2510 − 2055 = 455). And it can happen even though the antenna-tuning circuit is actually tuned to 1600 and is expected to reject the interfering signal (see Fig. 10). There's so much gain in the IF amplifier, plus poor selectivity in the RF tuning circuit, that "images" often bull their way past the receiver front end and into the IF strip. These are the mysterious police or aircraft stations heard in FM radios, or teletype and other out-of-band signals in CB and ham sets.

There's a cure for images, but it's neither simple nor cheap. One technique is to raise the IF frequency from, say 455 to 1600 kHz. The idea is that the higher the IF value, the more distant in frequency a signal must be to create an image. This removes the objectionable signal so far from the band of operation that even poor selectivity of an RF tuning circuit is able to reject it. There is, however, a limit. As you'll recall, selectivity of an IF amplifier is good because of low operating frequency. An attempt, therefore, to remove the image by raising the IF frequency can become self-defeating. Good receivers, though, capture the benefits of both high and low IF frequencies.

Takes Two to Tango. The dual conversion circuit, found in much CB, ham and communications equipment contains *two* IF amplifiers. One is tuned to a high IF frequency to obtain the benefits of good image rejection. The second amplifier is at a low frequency to net high selectivity. An example of how the system operates is shown in Fig. 11. Note that a second local oscillator is required for the two-step conversion.

RF Amplifiers. Now return to the front

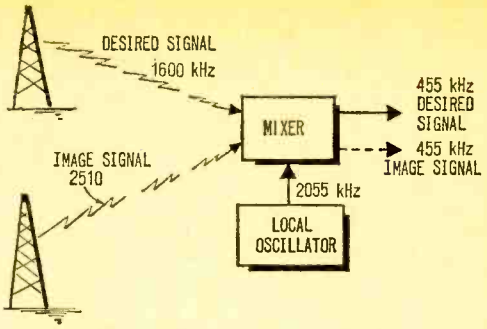


Fig. 10. The problem with superhet circuits is images. Two different frequency signals may mix and create 455-kHz IF signals that interfere.

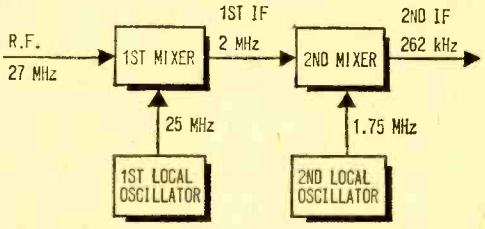


Fig. 11. Dual-conversion superhet operates by two-stepping down to the low IF—27 MHz to 2 MHz and then from 2 MHz to 262 kHz. Used a lot in CB rigs.

end of the receiver to examine another image-killer. It's the RF Amplifier. The stage places more tuned circuits before the mixer so an image signal out of the band is less likely to get through. Another benefit is that the RF stage also boosts the superhet's sensitivity, or ability to amplify weak signals. The table radio of the last few decades, however, has rarely included an RF stage. Local AM stations are usually strong enough to drive the mixer directly and the additional components are hardly worth the added expense in very low-cost receivers.

An RF amplifier, however, is almost always found in the car radio, FM tuner and TV set. An important reason is that as RF frequency rises much above 15 MHz, atmospheric noise decreases and internal circuit noise becomes increasingly a problem. This is minimized by adding a well-designed RF amplifier. It can produce less internal noise than a mixer stage. And it's mostly in the first stage where a receiver's "signal-to-noise" ratio is determined. Tune a cheap short-wave receiver, with no RF stage, and you'll probably hear the speaker grow quiet on higher bands, a giveaway sign of poor sensitivity.

There's a similar reason for an RF amplifier appearing in virtually every car radio. It's because mobile operation imposes a spe-

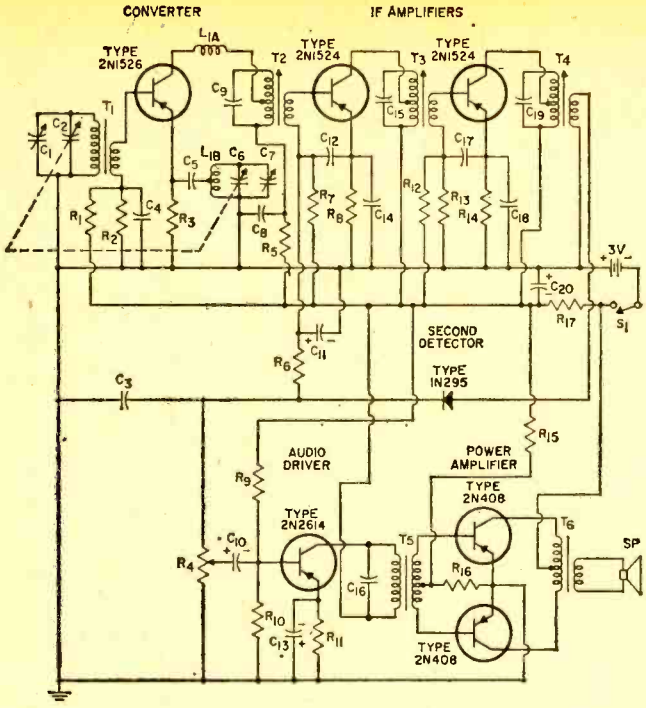


Fig. 12. It figures that the transistor would make it big with the superhet circuit. Some circuit design had to come about to reduce costs. The first stage, "converter," combines the functions of mixer and local oscillator.

cial stress on reception. A car is often driven between cities where borderline signal strength is encountered. Every bit of sensitivity is needed under mobile conditions.

Which IF? The standard automobile radio has an IF frequency of 262 kHz instead of the standard 455 for home sets because listening is often done between cities. In a given city, the FCC assigns AM stations a minimum spacing on the dial of 20 kHz. An ordinary table radio has little trouble separating such stations. But if you drive between cities, you could pick up two AM stations from different cities with only 10 kHz spacing. Now the set requires additional selectivity to pull them apart. This is done by the choice of a lower 262 kHz IF. You could object and say that a lower IF value aggravates the image problem. It would—if it weren't for the use of an RF amplifier in car radios. It improves selectivity and helps cut the images.

There are several other IF frequencies now in use, mainly depending on the band of operation. A low value of 455 kHz is not practical for the FM broadcast band (88 to 108 MHz). It would make the receiver extremely susceptible to images since image frequencies could exist directly within, or near, the FM band. Effective rejection would be nearly impossible. So the IF frequency is at 10.7 MHz. It pushes images that far from the desired frequency. In television, the standard IF frequency is approximately 41 MHz.

All-American Five. During 1968, about 40 million radio sets were sold in the U.S.A. And chances are that circuitry in these radios will be virtually the same as in Fig. 8 if it's a tube model; or similar to Fig. 12 for transistorized models. These diagrams are representative of the most popular superhets now in use.

The tube model is sometimes called the "All-American Five," which refers to a 5-tube line-up found in zillions of AC/DC table radios. That title is being taken over by the 5-transistor equivalent. What's next? Probably the All-American IC—assuming that the integrated circuit isn't made in Japan.

An All-American One! Although most commercial superhets have about five stages, there's an ingenious circuit which uses just one tube! Its secret lies in a compactron tube which combines three amplifiers in a single glass envelope. It makes possible a one-tube circuit that fulfills all requirements of a true superhet. You can easily build and align it for the standard broadcast band, as we'll see in a moment. This is a homebrew project you can thrust under the nose of some electronic egghead and challenge him with: "Quick, name the circuit!" When he says TRF or regenerative, you snicker back, "Superhet." You can prove it by tracing out the diagram (in Fig. 13) this way:

RF Tuning. Broadcast signals in your area enter the antenna. The one you want to hear is selected by the tuning circuit of coil L1 and variable capacitor C3A. But we need better selectivity than is possible in an RF tuning circuit.

Local Oscillator. This is a job for a low IF. Part of tube V1A functions as a local

oscillator to heterodyne the incoming RF signal to 455 kHz. The oscillator is formed by a tapped coil and variable capacitor (L2-C3B). These components help drive the tube into oscillation; cathode (pin 10), grid (pin 2) and oscillator plate (pin 3). Notice that tuning capacitor C3 is a 2-section variable with a dotted line to show ganging. When the RF section is tuned, oscillator frequency also changes, and maintains its generated signal exactly 455 kHz above the incoming station.

Detect and Listen. The 455-kHz signal is now detected into audio by diode D1 and fed to the remaining triode amplifier (V1C) and to the loudspeaker for listening. Sorry, no AVC circuitry.

Now that you can prove that a superhet can be a one-tube wonder, how about trying your hand at building it? It may not blast

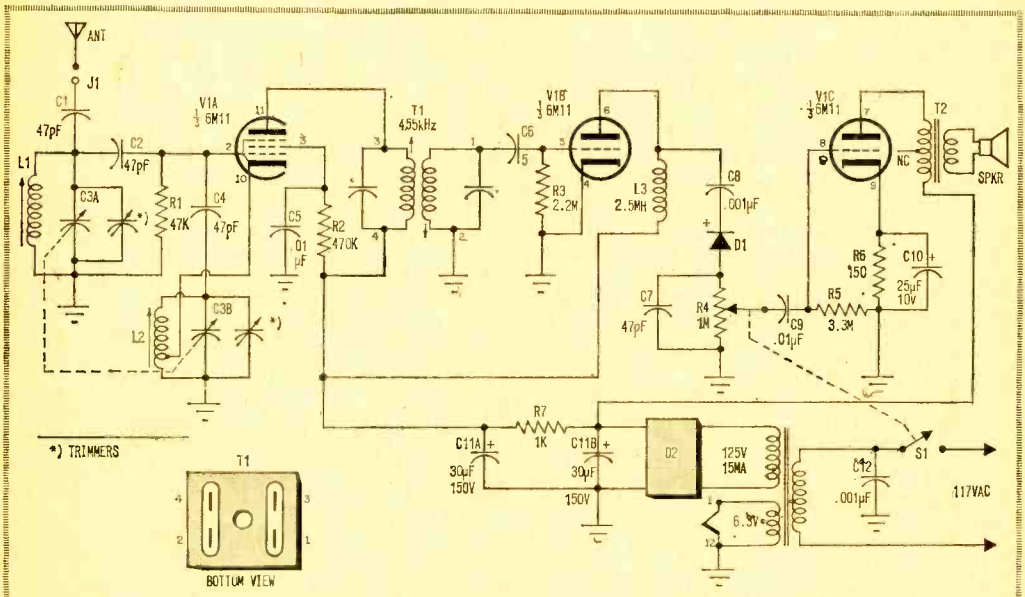


Fig. 13. You can build your very own superhet receiver using only one vacuum tube, the well-known 6K11 compactron tube. Look hard and you will be able to find almost all the functions of the superhet in the above circuit as you would in the famous all-American five circuit. But don't rush into the construction until the next issue is published. Then we will give you complete details, photos, diagrams, and parts list.

Mixer. Combining RF and local oscillator signals also occurs in tube V1A. As the electron stream from the cathode is varied by both oscillator and antenna signals at the grid (2), a resulting mixture appears at the plate (11). Several possible combinations exist at the plate—as various signals add and subtract. But only the 455 kHz difference frequency is extracted. The reason is the . . .

IF Amplifier. Transformer T1 is sharply tuned to 455 kHz and thus accepts only that frequency from the mixer plate (11). All else is sliced away and the IF frequency is amplified by triode V1B. The output of the IF amplifier in most commercial circuits is another IF transformer for additional selectivity. But this is a simple circuit for the experimenter so an untuned choke coil (L3) appears instead.

forth on weak AM signals, but it performs respectably well on local stations. Selectivity is about as good as that of an ordinary table radio. The project is ideal for an experimenter trying to squeeze the most performance out of the fewest parts. Need more help than offered by the schematic diagram? Then wait until the next issue of ELEMENTARY ELECTRONICS for the complete construction details. In the meantime be sure you understand all there is to know about superhets. ■

Spacecraft flights to other planets require the services of

THE BUG KILLERS

by Wes Robinson

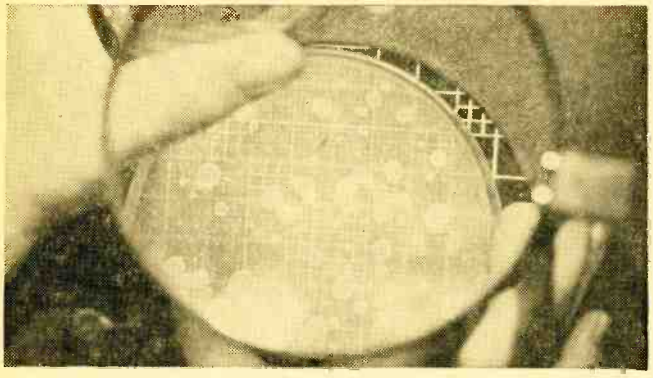
Imagine sterilizing a bullet in a laboratory, loading it into a germ-free rifle breech, firing the rifle and hitting the target with a lead slug still as clean as the moment it came out of the laboratory.

A comparable feat of far greater magnitude faces space scientists who are planning to send unmanned spacecraft to other planets. By international agreement, the United States has committed itself to land only sterile probes on the soil of neighboring planets. A craft landing on Mars, for example, must be 99.9999 per cent clean. The reason: man doesn't want to reach the surface of a distant planet only to rediscover transplanted biology from his own planet.

Bugacide. The killing of microorganisms on a spacecraft can be almost as much a matter of bookkeeping as it is microbe warfare. Contamination samples are taken from the first stages of spacecraft assembly through to the completed vehicle. Results of the "bug-count" sampling are fed into a computer, which keeps records of the microbial buildup. As the spacecraft becomes more complex, organisms begin to be added between attached surfaces, and bug counts must be taken with greater frequency. The sterilization heat cycle for a particular planetary landing vehicle will be based on the computer-calculated germ load for that vehicle.

Counting the number of microorganisms on a spacecraft bound for another planet is tough enough, but biologists also must predict all possible events which might affect the lander's sterility on its outward journey. Each potential event, such as a meteorite striking the vehicle and dislodging some bugs still alive but trapped within the struc-

Facts and Photos courtesy of Boeing Magazine

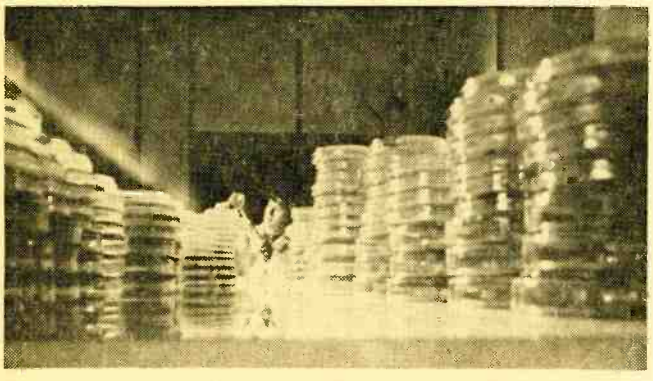


Microorganisms are treated with loving care provided they can survive being shot from guns like cereals. Bugs shown above made it.

ture, is assigned a "probability number" based on analysis and research. A computer then adds up all these probabilities, and comes out with an overall probability figure for contaminating a particular planet with a particular spacecraft at a particular time.

Heat Wave. Sterilization is an absolute term—either you have it or you haven't. To achieve it requires that a spacecraft literally be baked at 257 degrees Fahrenheit. This requirement has caused problems.

No large interplanetary vehicle ever has been oven-baked completely, although small vehicles and parts of larger spacecraft have. Certain spacecraft materials tend to resist heat and, in so doing, may protect "bugs" that have lodged under the surfaces of those materials. Some strains of microorganisms are tough to kill with heat. Heat can make some spacecraft materials brittle.



Thousands upon thousands of microorganisms are grown in the laboratory, cataloged in canisters and marked for extinction.

These and other problems have led engineers to ask the advice of biologists, metallurgists, manufacturing specialists and research scientists before they put even preliminary designs on paper.

Born to Die. At Boeing, the task of spacecraft sterilization begins in the laboratory. Here, Dr. Richard Olson and a small staff of assistants grow "bugs"—batches of microorganisms—and then think of ways to get rid of them. In the search for methods of sterilization, the microbes are baked, smashed, irradiated and subjected to rarified atmospheres. The results of this mayhem are catalogued and routed to others studying planetary quarantine.

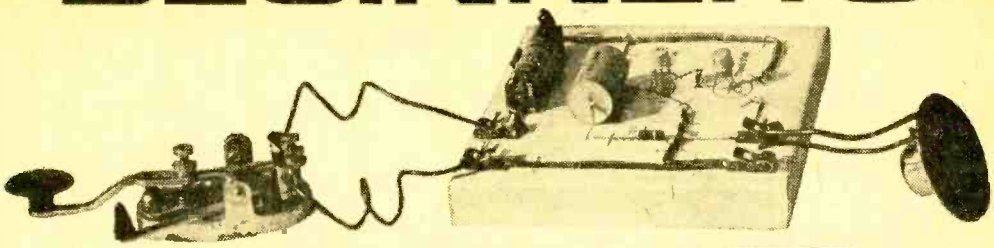
Dr. Olson's group is concentrating on killing one strain of germs in particular, a tough little bug of the aerobic (oxygen-liking) spore-forming classification called *Bacillus subtilis*. From an aerospace biologist's point of view, spore-forming organisms are troublesome. The spores resist the sterilizing effects of dry heat and prove to be much tougher to kill than normal cells. Dr. Olson believes that if these aerobic spores can be eliminated, all other organisms automatically will be destroyed in the process.

Boeing's sterilization research work is directly applicable to the proposed *Viking* project, a NASA assignment to land an unmanned probe on the surface of Mars in 1973. A team composed of researchers and designers from Boeing, General Electric and Hughes Aircraft is hoping to win the *Viking* bid over teams headed by McDonell Douglas and Martin Marietta. Although GE's primary concern will be with the spacecraft's entry into the Martian atmosphere, the company's sterilization experience on the now-canceled *Voyager* program also will prove valuable.

They're Everywhere. Experiments also have helped describe and suggest solutions to the sterilization problem. Boeing researchers, for example, found that micro-organisms buried within a solid propellant fuel might survive some rocket firings. How-

(Continued on page 99)

BEGINNER'S



CPO

Learn as you build with a circuit that'll clue you in on what oscillators are all about

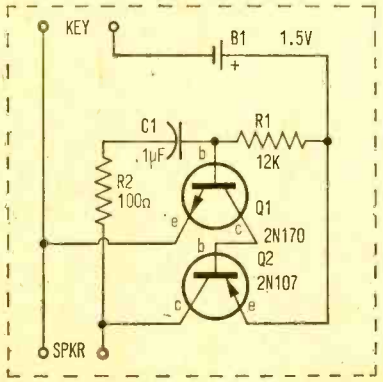
/ by Wayne Kiser, WA9VKP

☐ Getting started in electronics is almost always an exciting experience—almost, we say, because that first step can be so complicated that the poor beginner becomes confused and discouraged.

Here's a simple project that will make that first step easy for you or someone you may teach. Schematic symbols are the language of this new adventure. But how hard it is for the newcomer to relate symbols to the parts they represent! Reason is that parts placed on a chassis or on a printed circuit board don't look much like the neat drawings in a book. Even so, a simple schematic like that of an audio oscillator can help form the mental links necessary.

Tail Chasing. What's an oscillator? An oscillator can result when part of the output voltage is fed back into the input of practically any amplifier. The same effect results when a dog chases his tail. He goes round and round but doesn't get anywhere. In the case of the oscillating circuit, however, this changing voltage can be fed into a speaker, causing sound. The circuit we show here is that of a typical audio oscillator. And to understand it better, we suggest you draw the schematic on a board (see Parts List) right now, studying the symbols and the hookup of the circuit as you do so.

Here's how it works: when the key is closed, current flowing through the 12,000-ohm resistor (R1) into the base-emitter junction of the npn transistor (Q1) causes a



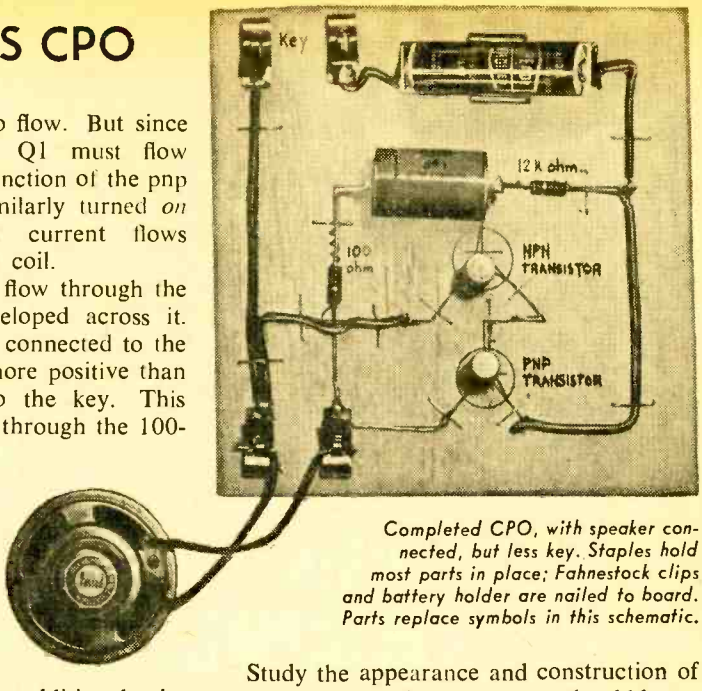
Schematic for Beginner's CPO. It's best to buy parts first, arrange them as per schematic, then draw schematic on wood block.

PARTS LIST FOR BEGINNER'S CPO

B1—1.5-volt penlight battery (Eveready 1015 or equiv.)
C1—0.1-uF capacitor
Q1—2N170 transistor
Q2—2N107 transistor
R1—12,000-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
1—5½ x 5½ x ¾-in. wooden block
4—Fahnestock clips
1—Telegraph key
1—Miniature PM speaker
Misc.—Wire, solder, staples, battery holder, etc.

collector-emitter current to flow. But since the collector current of Q1 must flow through the base-emitter junction of the pnp transistor (Q2), Q2 is similarly turned *on* and *its* collector-emitter current flows through the speaker voice coil.

When current begins to flow through the speaker, a voltage is developed across it. Result is that the terminal connected to the collector of Q2 becomes more positive than the terminal connected to the key. This positive voltage is coupled through the 100-ohm resistor (R2) and the 0.1-*u*F capacitor (C1) back to the base of Q1, causing additional base-emitter current to flow in both transistors. This is the tail chasing, because additional collector current flows, and this in turn causes additional voltage to be developed across the speaker.



Completed CPO, with speaker connected, but less key. Staples hold most parts in place; Fahnestock clips and battery holder are nailed to board. Parts replace symbols in this schematic.

Repeat Performance. This cumulative action continues until the capacitor is fully charged. At this point, the like charges on both sides of the capacitor begin to repel and the voltage at Q1's base becomes more negative. This decreases current flow in the collector of the npn transistor (Q1), and this in turn causes the collector current of the other transistor to decrease as well. Eventually, the voltage across the speaker reaches zero. When this happens, current again flows through R1 into the base-emitter junction of Q1 and the cycle begins all over again.

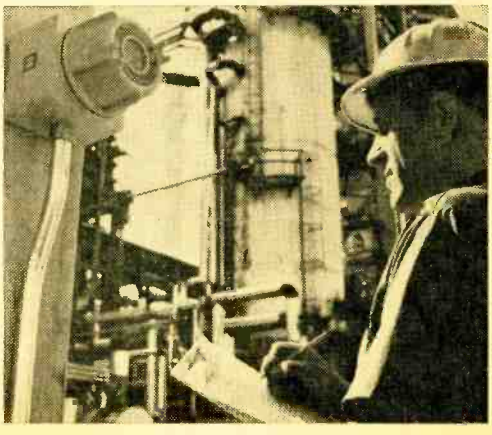
Study the appearance and construction of the few parts used. By now you should know what each part is and how it works. When explaining the workings of components to other people who haven't much previous knowledge, though, be extra careful not to give too much information at one time.

The final step is to place the parts on the schematic you drew earlier and solder the connections. The wires can then be stapled directly to the wooden block.

Connect the speaker and the key, and the oscillator is ready for work. The completed project can be useful in learning the code, or, through use of transistor sockets instead of direct connections, for testing which transistors are npn's and which are pnp's. ■

Hot News For Your New Flame

A new ultraviolet fire detector that reacts to the first trace of flame, then flashes an immediate alarm has been developed by Honeywell's Apparatus Controls Division. Because this new detector is sensitive only to ultraviolet radiation, it responds only to an actual flame or explosion. It can't be fooled by heat or infrared radiation or even sunlight. In fact, it can stare at the sun all day without giving an alarm, since it actually has trouble telling day from night.



e/e's all NEW BASIC COURSE in ELECTRICITY & ELECTRONICS*

PART 1

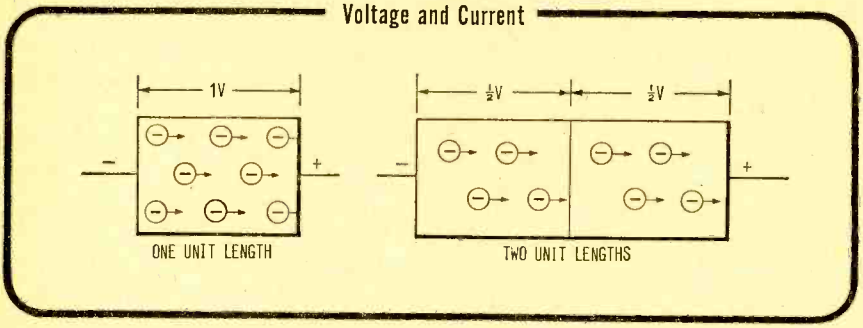
UNDERSTANDING DC SERIES CIRCUITS

WHAT YOU WILL LEARN. This is part one of a brand new continuing series and contains a thorough description of the series circuit and its basic connections. It also explains how total resistance, total current, and voltage drops are determined in such a circuit. You will learn how to reduce a voltage to a desired level by the use of a dropping resistor, identify series connections in complex electronic circuits, and determine total resistance and total current in a series circuit. *(Turn page)*

* This series is based on Basic Electricity/Electronics, Vol. 1, published by Howard W. Sams & Co., Inc.

WHAT IS A SERIES CIRCUIT?

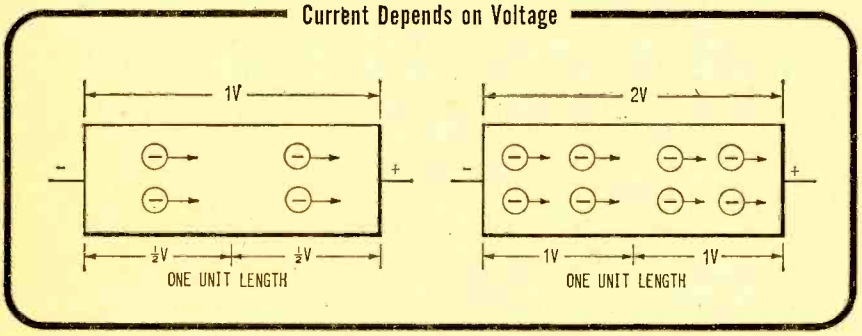
A *series circuit* is an electrical circuit in which all the components are connected end to end.



Do you recall the voltage distribution which occurs across a resistance? If one volt is applied across one unit length of wire, for example, what will happen to the voltage distribution across the same size wire that is twice as long? One-half volt will appear across each unit length. One-half the total voltage will be dropped across each of the two units. Since the resistance is doubled, the current will be one-half as much.

VOLTAGE DISTRIBUTION

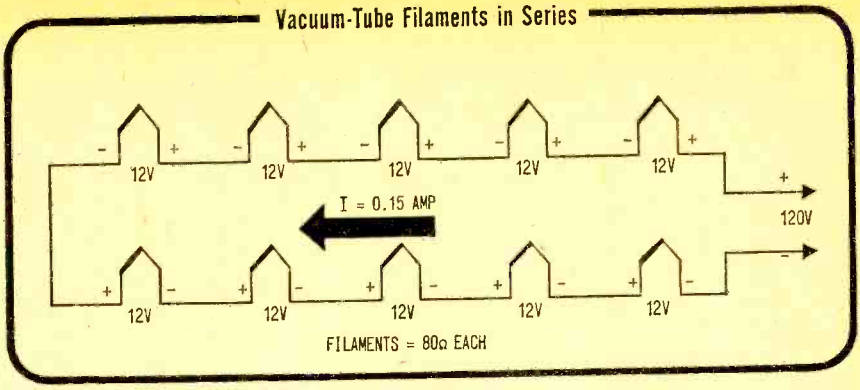
Voltage will be distributed across the unit length of resistance in the manner shown in the diagram. Doubling the voltage will cause twice the current to



flow through the resistance. One volt is distributed (dropped) across each half of the resistance, increasing the current that flows through its section.

An example of a series circuit is the manner in which the vacuum-tube filaments of some radio and television sets are connected. As you can see in the following diagram, each filament requires 12 volts and a current of 0.15 ampere. This identifies another characteristic of a series circuit—all components in a series circuit have the same current flowing through them.

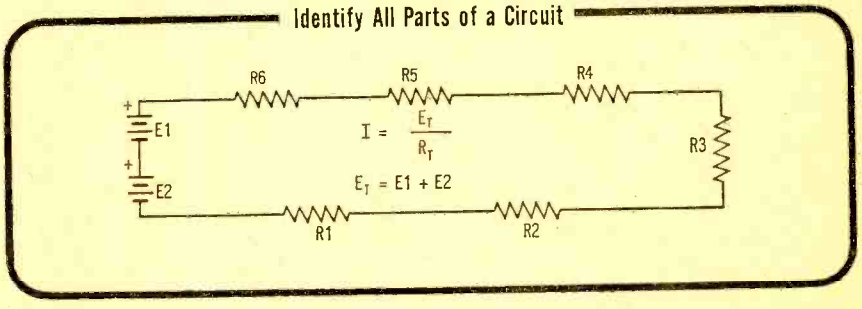
Another application of the series circuit is the economical series-string Christmas-tree lamps. The number of lamps needed in a string or the amount



of voltage to apply can be determined by Ohm's law. If the voltage drop required by each lamp is 15 volts and the string is to be connected to a 120-volt outlet, then eight lamps are required in series.

Symbol Designations

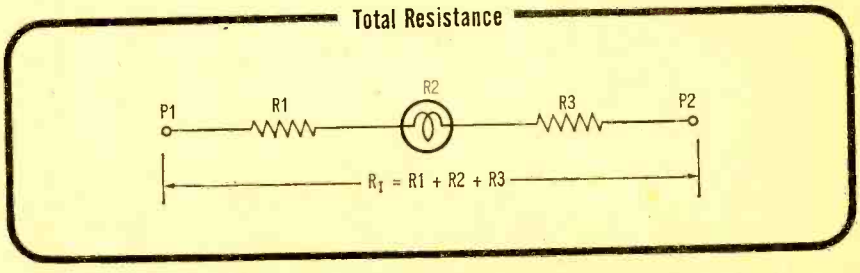
Care must be used when referring to voltage in a series circuit. A voltage drop across one resistance among many may be a different value from the IR drop across the others. A voltage across R_1, for example, should be identified as that voltage. The source voltage should be designated as E_T (for E total). Total resistance becomes R_T. Since current is the same in all parts of a series circuit, it remains as I.



Total Resistance in the Series Circuit

Current in a series circuit is determined by the values of *total resistance* and *total voltage*. The total source voltage is distributed proportionally across each of the series resistances, depending on their ratios to the total resistance.

Total resistance in a series circuit is the sum of the resistances between the terminals of the source. That is, R_T will equal $R_1 + R_2 + R_3 +$ etc.



The lamp shown above does have a resistance, even though it is not a resistor. Therefore it is marked as R_2 for calculation purposes.

Q1. Can the circuit on the opposite page be called a series circuit?

Q2. The symbol for total voltage is _____.

Q3. If R_1 is 4.5 ohms, R_2 is 6 ohms, and R_3 is 6 ohms in the diagram above, what is R_T?

Your Answers Should Be:

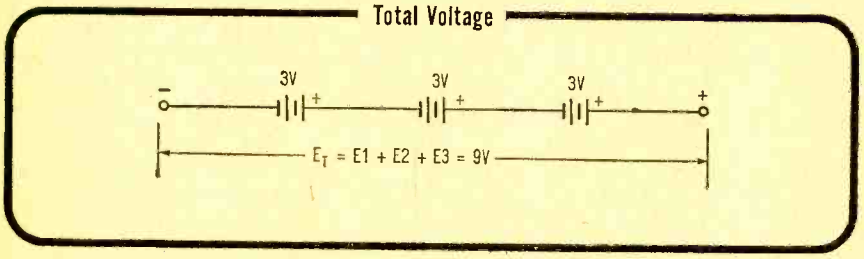
A1. *Yes.* All elements are connected end to end.

A2. The symbol for total voltage is E_T.

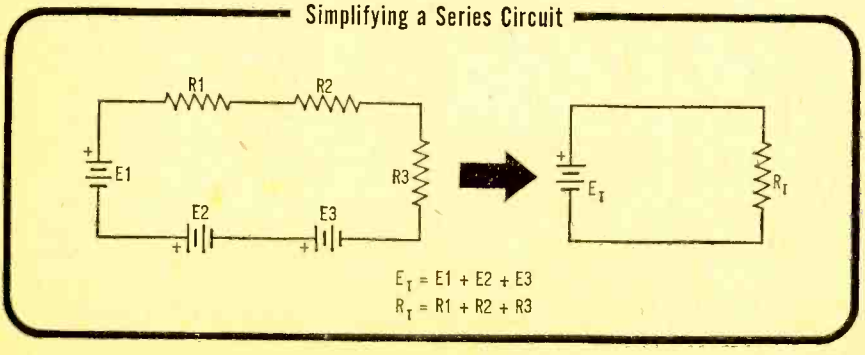
A3. $R_T = 16.5$ *ohms.* (The total resistance in a series circuit is the sum of all the resistance values across the source.)

Total Voltage in a Series Circuit

In addition to determining the total resistance of a series circuit, the total voltage must be calculated if there are two or more voltage sources in series. Total voltage is found in the same manner as the total resistance; that is, the sum of the individual voltages equals the total voltage.

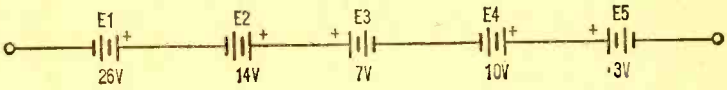


There is a separate problem in the calculation of total voltage, however. Some of the voltage sources may be in opposition to others, in which case the total voltage will not be the simple numerical sum of all the voltages. If the polarities of all the voltage sources are in the same direction, the voltage values are added together. If the polarities are in opposite directions, the values are subtracted, and the polarity of E_T is that of the larger voltage source.



A series circuit with more than one source and more than one load can be redrawn to show a circuit with only one source and one load.

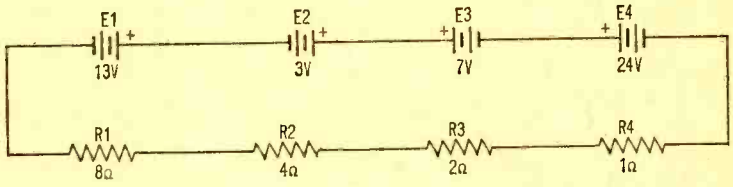
Q4. How must you treat the following series circuit to find the total source voltage?



Q5. What is E_T for the circuit below?

Q6. What is R_T for the circuit below?

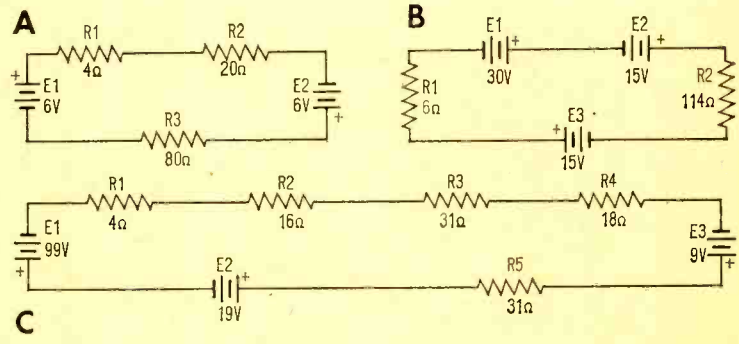
Q7. What is I_T for the circuit below?



Q8. In which direction will current flow in the circuit above?

Q9. Could the total resistance be represented by a single resistor?

Q10. What is the total resistance in each circuit (a, b, and c) below?



Q11. What is the total voltage in each circuit?

Q12. Draw an equivalent circuit, containing only one source and one load, for each of the circuits. Label the value and polarity of the source and the value of the resistance.

Your Answers Should Be:

A4. You must first add all the voltages having a polarity in one direction (negative to plus). Then add all the other voltages having a polarity in the other direction. Subtract the smaller from the larger. This will determine the amount of the overall voltage (E_T) and its polarity.

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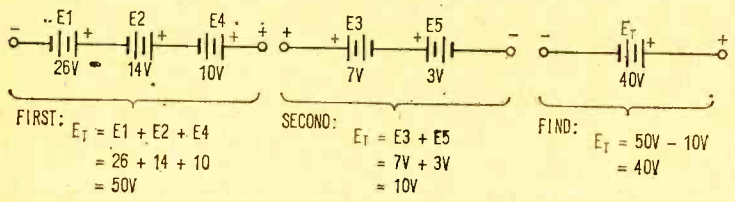


A5. $E_T = 24 + 7 - 13 - 3$. That is, $31 - 16 = 15$. Therefore, $E_T =$ *15 volts*, negative to positive left to right.

A6. $R_T = R_1 + R_2 + R_3 + R_4$. $R_T = 15$ *ohms.*

A7. $I_T = E_T/R_T$. $I_T = 15/15$, or *1 amp.*

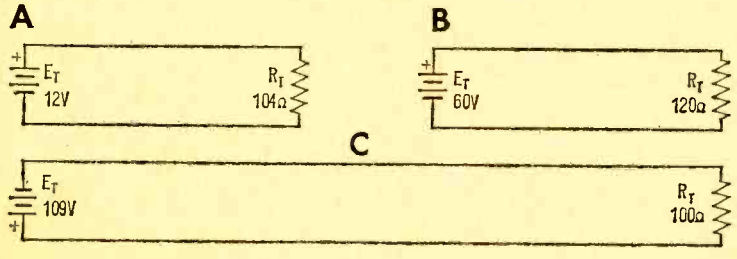
A8. The current will flow *away from the negative terminal and into the positive terminal of* E_T.

A9. *Yes.* Once the total resistance has been found, it may be represented by a single resistor.

A10. (a) *104 ohms*
(b) *120 ohms*
(c) *100 ohms*

A11. (a) *12 volts*
(b) *60 volts*
(c) *109 volts*

A12.



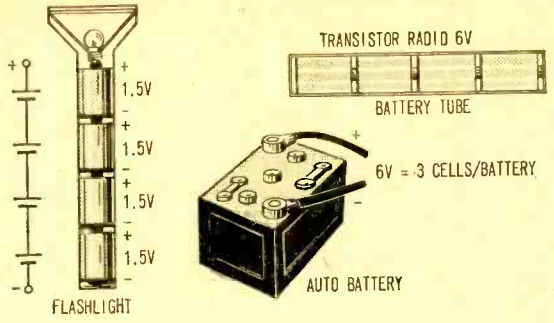
Examples of devices having several voltage sources in series are flashlights, transistor radios, battery sleeve or tube, and automobile batteries. (See diagram top of next page.)

Current in a Series Circuit

If a series circuit has an R_T of 170 ohms and an E_T of 34 volts, what is the current in the circuit? The current will be equal to E_T/R_T or 0.2 ampere (34/170). If a series circuit has three sources (all aiding one another) and two resistances, current can be determined by:

$$I_T = \frac{E_1 + E_2 + E_3}{R_1 + R_2}$$

Voltage Sources in Series



Voltage Drop in a Series Circuit

The voltage drop across each resistance in a series circuit is found in the same manner as the voltage across a resistor if the resistance value and the current flowing through the resistor are known. The Ohm's law expression is $E = IR$. Voltage across a resistance is determined by multiplying current by resistance.

The current is the same through each resistance in a series circuit. After finding the current, the value of I is used to determine the voltage drop across each resistance in the circuit.

Q13. What is the total voltage of a source having eight 1.5-volt flashlight cells connected in series?

Q14. What is the total voltage of a source having fifty-five 2-volt lead-acid cells connected in series?

Your Answers Should Be:

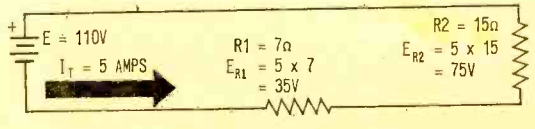
A13. Eight 1.5-volt dry cells connected in series will develop *12 volts.*

A14. Fifty-five 2-volt lead-acid cells connected in series will provide *110 volts.*

Determining Voltage Drops

The sum of the voltage drops in a series circuit is always equal to the total applied voltage.

Voltage Drops Equal Applied Voltage

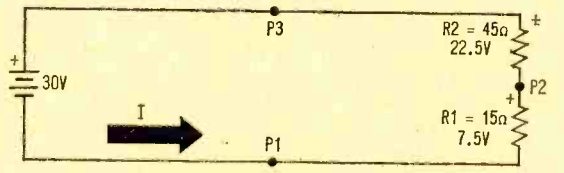


In the previous circuit, 5 amps will cause a 35-volt drop across the 7-ohm resistor and a 75-volt drop across the 15-ohm resistor. $E_{R1} + E_{R2} = E_T$.

Polarity Across the Loads

Current leaves the negative terminal of a voltage source, flows through the circuit, and returns to the positive terminal. This direction of current flow occurs because of the voltage polarity. One of the terminals of the source is negative (repels electrons) with respect to the other. The opposite terminal is positive (attracts electrons). In the diagram, for example, P_1 is 30 volts negative with respect to P_3.

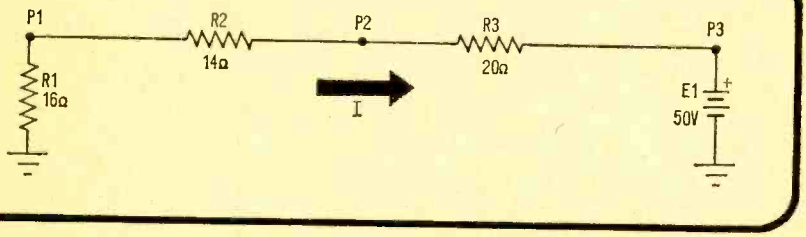
Polarity Across Loads



Voltage in a circuit exists only between two points—never at one point only. Therefore, voltage is expressed as being across two points in a circuit, or in terms of one point with respect or in reference to another point. The point at which current enters a resistance is negative with respect to the point at which it leaves.

A common ground is used as the reference point for expressing voltages unless otherwise specified. If a ground symbol is shown (see the diagram below), it becomes the common reference point for all voltage points in the circuit.

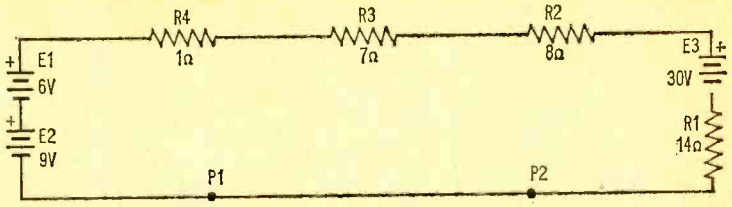
Ground Is a Reference Point



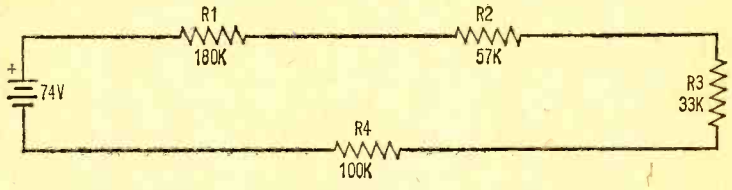
Current will flow from P_1 to P_2 to P_3 through the source to ground and from ground to P_1. In this case, I is equal to 1 amp. This means P_1 is +16 volts with respect to ground. P_2 is +14 volts with respect to P_1 (thus 30 volts positive to ground). P_3 to ground (in either direction) is +50 volts (the source voltage or the drop across the three resistors).

Q15. What is the value of E_T in the circuit below?

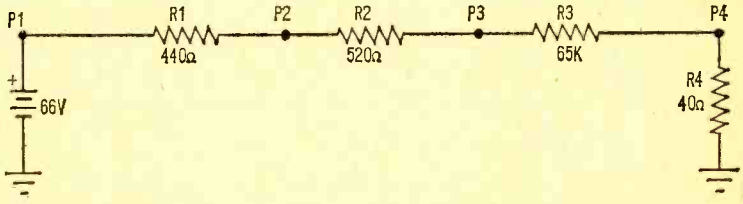
Q16. What is I_T in the following circuit? Which way will current flow with respect to P_1 and P_2?



Q17. What is the total resistance of the following circuit?



Q18. What is the voltage, with reference to ground, for all the points (P) on the following diagram?



Your Answers Should Be:

A15. *15 volts.*

A16. $I_T = E_T/R_T$. $E_T = E_3 - (E_1 + E_2) = 15V$
$R_T = R_1 + R_2 + R_3 + R_4 = 30$ ohms
$I_T = 15V/30 = 0.5$ *amp*
Since the 30-volt source is larger than the combined 15 volts of the other two, the *current will flow from P_2 toward P_1.*

A17. *$R_T = 370K$.*
That is, $R_T = R_1 + R_2 + R_3 + R_4 = 370K$

A18. $I_T = \dfrac{E_T}{R_T} = \dfrac{66V}{66K} = 0.001$ amp, or 1 ma
$P_1 = +66V$, $P_2 = +65.56V$.
$P_3 = +65.04V$, $P_4 = +0.04V$

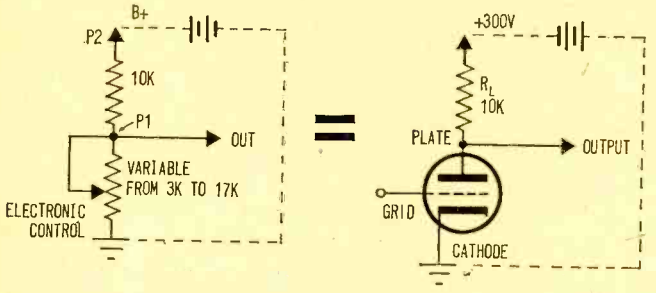
Voltage Division in a Series Circuit

Voltage reference is one of the most important concepts to be learned in electricity or electronics. An understanding of how much voltage exists between two points in a circuit often reveals the purpose of the circuit and how it works.

As an example, a schematic of a vacuum-tube circuit is shown below. The figure on the right shows a vacuum tube in series with a load resistance, R_1.

The figure on the left shows how the tube can be considered as a variable resistance. The output of this circuit is taken at a point between the tube and the load resistance.

Voltage Reference

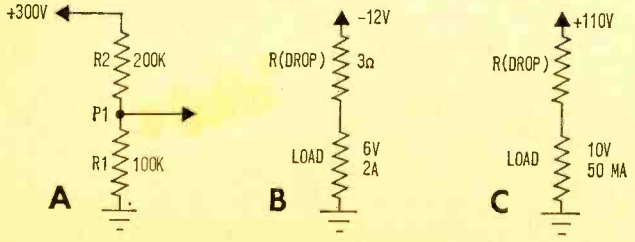


In effect, the grid varies the resistance of the vacuum tube. P_2 is always +300V (to ground). P_1 is a positive voltage (to ground); its value depends on tube resistance at any particular instant. The tube resistance changes from 3,000 to 17,000 ohms. Since 300 volts is always across the tube and load resistance, the output voltage at P_1 (with respect to ground) is large when tube resistance is high and small when tube resistance is low.

VOLTAGE DIVIDER

Current is the same through all elements in a series circuit. In the circuit on the opposite page the 300 volts can also be used for other purposes and in other circuits. Yet, 300 volts is often too much voltage for some circuits. A voltage divider is used to reduce the 300 volts to a level acceptable for use in a lower-voltage circuit. To select the correct resistors for use in a voltage divider, you must know how much voltage is required by the lower-voltage circuit. A voltage divider, therefore, is a series of resistances whose values are such that the desired output voltages are obtained at the various points with respect to the voltage reference point. In some cases, a voltage dropping resistor is connected in series with a load to obtain the desired voltage.

Voltage Dividers



Q19. What is I in the voltage divider of part A above?

Q20. How much voltage is available at P_1 in part A?

Q21. R (drop) in part B above is a(an) ——————— resistor.

Q22. Load voltage (part B) is _____ to ground.

Q23. ——— ampere(s) flow through R (drop) in part B.

Q24. R (drop), part C, is _____ ohms.

Q25. The load in part C dissipates _____ watt(s).

Your Answers Should Be:

A19. *0.001 amp, or 1 ma.*

A20. *100 volts.* $E = I \times R_1$. 0.001 amp multiplied by 100,000 ohms.

A21. R (drop) in part B is a *voltage dropping* resistor.

A22. Load voltage (part B) is *−6V* to ground.

A23. *Two* amps flow through R (drop) in part B. (Current is the same throughout a series circuit.)

A24. R (drop), part C, is *2,000* (or 2k) ohms.
If the voltage across the load is 10 volts, R (drop) must have 100 volts across it. 100 volts divided by 0.05 amp (circuit current) is 2,000 ohms.

A25. The load in part C dissipates *0.5* watt.
$P = IE$. (Current through the load multiplied by the voltage across the load.)

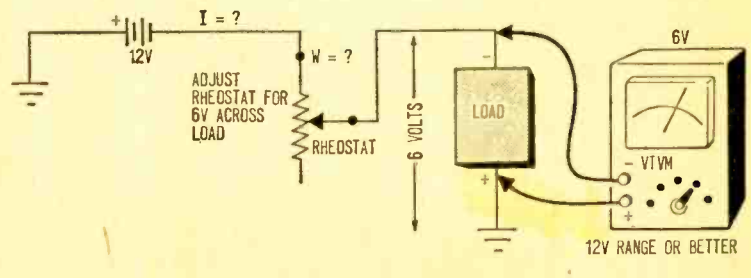
PRACTICAL APPLICATION OF THE SERIES CIRCUIT

In addition to what you have learned, there are many other applications for a series circuit. They exist in almost every electrical device used.

Reducing Output Voltage of a Battery

A voltage-dropping resistance can be used to lower the output of a 12-volt battery to operate a 6-volt device (radio, meter, lamp, etc.). The dropping resistor (when in series with the load) must have a value in ohms which will

Reducing Voltage with a Rheostat



permit the desired amount of current to flow through the device. It must also have the proper wattage rating as determined by its current and voltage drop.

A rheostat (variable resistor) is quite often used as a dropping resistor in this application.

The circuit on the previous page requires many careful adjustments and a common-sense application of Ohm's law and power equations. Solutions to the voltage-current-resistance problems are no more difficult than those you have already solved.

Steps in the Adjustments of the Rheostat

1. Determine the approximate current the load will draw. The device should be marked with its voltage and current requirements. The information can also be found in the service manual for this particular component.

2. Be sure the multimeter is set on a voltage scale which will read the source voltage (12 volts in this case).

3. Adjust the rheostat for 6 volts across the load.

> **NOTE:** The rheostat must be of high enough wattage to carry the load current.

4. Be sure the device can be switched on and off.

5. Put a fuse in the device. The fuse should be capable of carrying the current requirements of the load, while protecting it from an accidental overload.

Q26. If you do not know the current through the load and the rheostat, and you do not have an ammeter which will measure the current, how do you find the power required for the rheostat?

Q27. How do you determine the size of the fuse?

Q28. Why should the multimeter be set to the range which can read the voltage of the source?

Your Answers Should Be:

A26. You know the voltage drop across the rheostat, and you can measure the resistance of the rheostat from the end of he wiper contact.

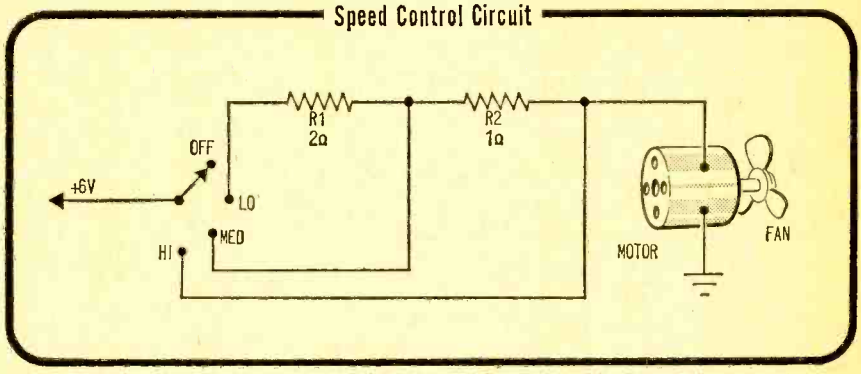
$$\text{Power} = \frac{E^2}{R}$$

A27. The fuse must be able to carry the calculated current and should be able to carry normal surges. Normal surges are determined by the characteristics of the device (load).

A28. The voltage range of the multimeter must always be set to the scale that you know will not be exceeded. Voltage greater than the range of the meter can cause excess current through the meter and, therefore, cause possible damage.

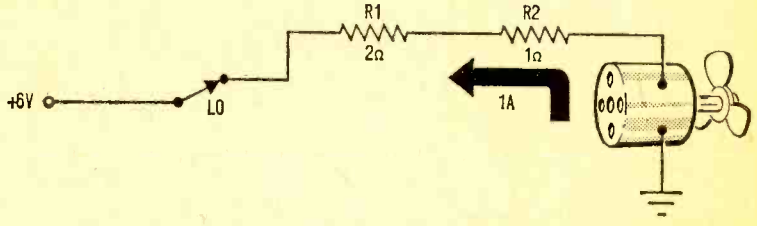
Speed Control for an Electric Motor

Motors, such as the one used in an automobile for the defroster fan, are sometimes connected to a switch having four positions (OFF-LO-MED-HI). The low and medium positions are separated from the high position by fixed resistors. Assume the motor turns at three speeds which require 3V at 1 amp (LO), 4.5V at 1.5 amps (MED), and 6V at 2 amps HI). This circuit is shown below.

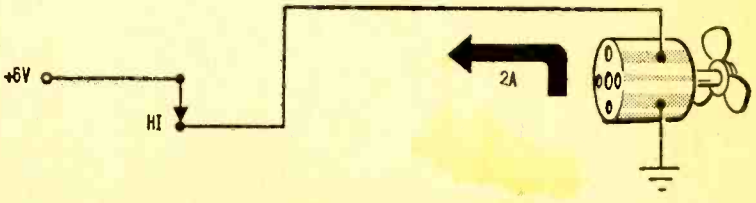


In the LO position the series resistance equals 3 ohms, which permits 1 ampere of current to flow. The 3 ohms is not the only resistance in the circuit. The motor adds its resistance in series with the circuit. In the MED position of the switch, the series resistance is 1 ohm. Again, the motor resistance is in series with it.

Q29. What is the resistance of the motor when the switch is in the LO position?



Q30. What is the resistance of the motor when the switch is in the HI position?



Q31. What is the power requirement for each of the two resistors, R_1 and R_2?

Q32. What type of switch would be the one most likely used?

Your Answers Should Be:

A29. The voltage applied to the motor in the LO position is 3V. The current is 1 amp. Therefore:

$$R = \frac{E}{I} = \frac{3}{I} = \textit{ohms}$$

A30. *3 ohms again.* The full 6 volt is across the motor.

A31. It is determined by the largest amount of current which will flow through the resistors.

$P_{R2} = I_{R2} \times E_{R2} = 1.5 \times 1.5 = 2.25$ watts

$P_T = (E_{R1} + E_{R2}) \times I_T$. $E_{R1} = R_1 \times I_T$, and $E_{R2} = R_2 \times I_T$.

$E_{R1} = 2 \times 1 = 2V$, $E_{R2} = 1 \times 1 = 1V$.

$P_{R1} = 1$ amp $\times$ 2V = 2 watts, $P_{R2} = 1$ watt.

Therefore, R_1 must have a power rating no smaller than *2 watts*. The rating of R_2 must be no smaller than *2.25 watts*.

A32. The most probable selection for the switch would be a *rotary or wafer type.*

WHAT YOU HAVE LEARNED

1. The basic electrical circuit is a series circuit.
2. A series circuit may have more than one source and load.
3. Current in a series circuit is the same through all components.
4. Total resistance in a series circuit is computed by finding the sum of all the resistances. That is, $R_T = R_1 + R_2 + R_3$ plus whatever additional resistors may be in series.
5. Total source voltage in a series circuit is the sum of the individual sources if their polarity direction is the same, or is the difference of the sums of the opposing potentials. The larger will become E_T and will control the direction of current.
6. A series circuit may be represented with an equivalent circuit.
7. Total voltage drop in a series circuit is equal to the source voltage, or E_T.
8. To describe a voltage at any given point you must identify its polarity with respect to a reference point.
9. A voltage divider is a series circuit which employs a dropping resistor to provide a desired voltage output.
10. When a dropping resistor is used to form a voltage divider, it must have a safe power rating.

This series is based on material appearing in Vol. 2 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $19.95. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

The Bug Killers

Continued from page 82

ever, certain liquid rocket propellants turned out to be self-sterilizing. Researchers also discovered that the broad panels of solar cells, used to generate electric power on a space flight, could provide shade and comfort to some germs. Solar cells are a spacecraft necessity, so Boeing is examining a potential antidote: the intense ultraviolet radiation in space may be a natural bug killer.

"The trip through the disagreeable environment of space might very well help us decontaminate some parts of the spacecraft," Dr. Olson said.

Dropping the Other Shoe. There are other tests, too—violent tests. Dr. Olson and his staff have loaded test samples with microorganisms, then drop-hammered them onto a steel base plate with the force of a locomotive crunching into a concrete wall at 100 miles an hour. The purpose is to see how many organisms would live if hard impact on a planetary surface becomes inevitable. Dr. Olson also has put germs into plastic bullets and fired the bullets into sterile steel canisters at velocities of 550 to 3100 feet per sec. The findings: the higher the impact force, the fewer organisms live through it.

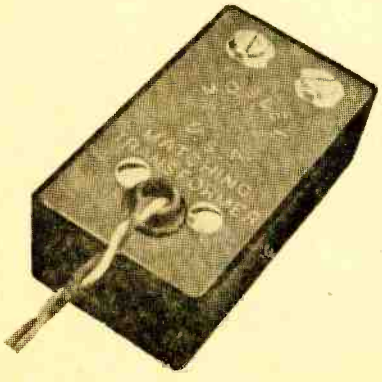
Boeing also conducted tests to see if microorganisms, given a reasonably comfortable entry and landing, could actually survive in a Martian environment. Data from Mariner 4, a spacecraft which flew to within 2400 miles of Mars, set the specifications for simulating the environment of another planet—a trace of water, basic limonite soil, a 70 per cent carbon dioxide atmosphere, strong sunlight, low temperature and a reduction of atmospheric pressure. A mixture of organisms, including *Bacillus subtilis* spores, spent eight days and nights in this environment, provided by a space chamber. Dr. Olson found that as long as the microorganisms are shaded in some way and not exposed directly to solar radiation, they will survive. Even now data from Mariners 6 and 7 is backing up their findings.

However, the Boeing biologist had some encouraging words. "We know very little about Mars, only the information Mariners 4, 6 and 7 managed to give us," Dr. Olson said. "These probes showed there is probably less than one per cent water on the planet. If this is true, terrestrial organisms most likely will not be able to grow and spread."

Even so, Dr. Olson and his group are working hard to make the odds one million to one against an Earth bug finding a new home on some other world. ■

Hey, Look Me Over

Continued from page 22

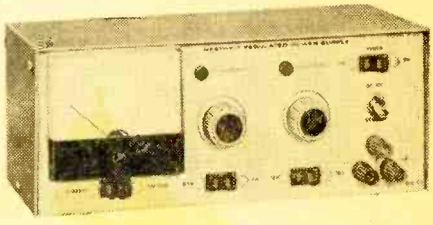


Mosely TRS-57 Transformer-Balun

band reception, eliminating the need for an additional antenna to receive local stations and distant cities. On regular shortwave bands, the TRS-57 acts as a balun to provide balanced receiver input. You can install it on the back of your SWL receiver with a screwdriver. Adaptable to any shortwave listening doublet, the TRS-57 is $7.43 and more information can be had from Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

Are You a Solid-State Experimenter?

Heathkit's new IP-28 regulated power supply should appeal to experimenters who work with solid-state circuitry. Without using the



Heathkit IP-28 Regulated Power Supply

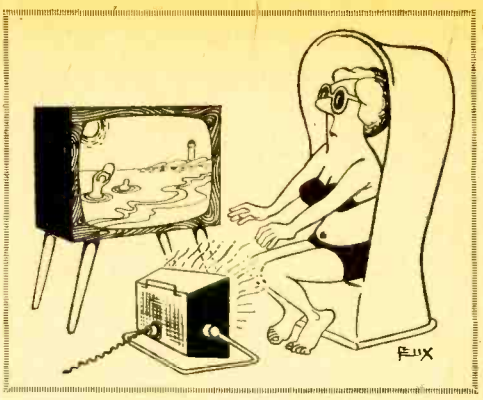
sensing terminals it delivers up to 30 VDC at 1 amp maximum load with less than 50-mV variation. There's a Remote Sensing feature that reduces the voltage variation at the load

to less than 20 mV. A front panel rocker switch selects either 1-10 VDC or 1-30 VDC ranges, and the output is continuously variable. The IP-28 also has variable current limiting in two switch-selected ranges from 10-100 mA or 10 mA to 1 A. A 3½-in. meter can be switched to read either voltage or current, with two pilot lamps indicating which is being monitored. Styled in beige and brown like the rest of their instrument line, Heath says the IP-28 goes together in about 8 hours with circuit board-wiring harness assembly. Price is $47.50 and you can get more specs from Heath Co., Benton Harbor, Mich. 49022.

Bell & Howell Road Runner Cassette Kit

Beep-Beep! Beep-Beep!

Do the kids bug you on road trips? Bell & Howell has devised the Road Runner cassette tape player kit to keep them off your back. Besides the Road Runner cassette, six batteries and earphone, the kit contains two original tapes with stories, travel facts, behavior tips, sing-along songs and games, all set to original music. There's also a travel booklet and a special prerecorded cassette tape bonus offer. The package comes in a sturdy travel carton with handle and sells for $38.88. If you bought the elements separately they would come to $45.00. The Road Runner cassette features touch control for fast forward, play or stop, easy drop-in cassette loading, and a rugged case. You can, of course, use all standard cassette tapes in the Road Runner. At your local dealer or write to Bell & Howell, Video and Audio Products Div., 7235 N. Linder Ave., Skokie, Ill. 60076. ■



Knight-kit Combo

Continued from page 70

Building the Kit. The KG-392 can rightfully be considered a kit only by the wildest stretch of the imagination. The entire electronic circuit is supplied preassembled on a printed circuit board; the wiring is also preassembled in a color-coded harness. The builder simply drops the harness into position and solders about 30 connections.

An experienced builder took about 45 minutes to complete the kit; figure an hour and a half for a beginner. One helpful assembly note: unlike the case with most kits, you do *not* wrap the connections in the Sideman—the wires are prestripped for 1/16-in., so don't try to strip to ¼ in. Simply tack-solder to all connections—even the selector switch—and you'll have no problems.

How It Sounds. The KG-392's performance is quite good. The cymbal sounds like a cymbal, the snare is reasonably a snare, and the bass drum really booms. In fact, the bass is excellent when the unit is fed through a high quality music or hi-fi amplifier. With an inexpensive music amplifier, of course, the bass comes out as a "klonk" rather than a "thud" because the cheap, small speaker cannot handle the low bass tones and it frequency doubles and triples. A complete set of level and effect controls are provided which the user can easily adjust (with no fear of causing damage) to the desired effect-balance and quality (such as bass pitch and length).

The KG-392 Combo Sideman, priced at $49.95, is supplied complete with output cable, footswitch, and battery; an optional AC power supply will be available. For additional information, write to Allied Radio Corp., Dept. JR, 100 N. Western Ave., Chicago, Ill. 60680 ■

En Passant

Continued from page 30

or lose a clear Knight. Here is the analysis:

A. If 42 KxB, Q-R6# 43 K-N1, RxN! 44 QxR, Q-N7 mate.

B. If 42 KxB, Q-R6# 43 K-K1 (43 K-B2, QxRP# wins) RxN#! 44 QxR (44 K-Q1, R-Q6 wins) N-N7# wins the Queen.

C. If 42 KxB, Q-R6# 43 N-N2, NxN (or 43 . . . . QxP#) 44 QxN, R-K8#! 45 K-B2, R-K7# 46 KxR, QxQ# wins.

D. If 42 NxB (White must recapture or counter-attack) R-K7! 43 QxN (43 R-B8# only delays it a move or two) Q-B7# 44 K-R1, QxN mate.

E. If 42 N-B5, Q-R6 43 QxN, Q-N7 mate.

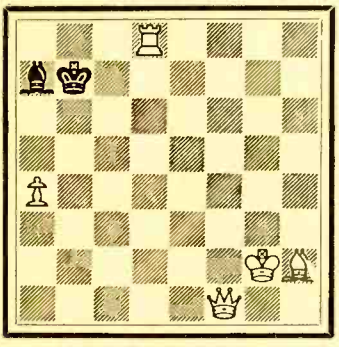
F. If 42 N-B5, Q-K8 (or 42 . . . . Q-R6 as in E) 43 QxQ (43 QxN, B-R6 mate) RxQ 44 R-B8# K-R2 and Black still has mating threats and a Bishop to the good.

Obviously, Black's 41st was a great deal more than a simple capture!

Problem 21

By W. von Holzhausen
German Chess Weekly, 1899

Black



White

White to move and mate in two.
Solution in next issue.

Herr Holzhausen's key is mighty shrewd!

Solution to Problem 20:1 Q-R6

If 1 . . . . KxN 2 Q-R6 mate. If 1 . . . . K-N7 2 N-Q3 mate. And if 1 . . . . PxN 2 Q-R1 mate.

News and Views. Three Americans flew to Natanya, Israel, to compete in that city's Eighth International Tournament. And they finished one, two, three—Samuel Reshevsky, Pal Benko, and Rev. William Lombardy. ■

Elementary Egotronics

Continued from page 43

she informs you in no uncertain terms that she adores chess players but has immense contempt for men who waste their time with electronic projects.

Would you:
A. Reluctantly and tactfully discontinue the relationship?
B. Hopefully build her an electronic chess set?
C. Ask if she knows any girls who build oscillators?
D. Hit her in the mouth?
E. _____

★ ★ ★

7. **Alone one evening, you are enjoying a little SWLing when you suddenly begin hearing a broadcast identifying itself as emanating from an alien spacecraft orbiting earth and from what the weirdly-voiced broadcaster says, you realize it's no put-on.**

Would you:
A. Feel quietly elated about the experience?
B. Decide it was only the result of that third martini?
C. Visit a psychiatrist?
D. Complain to the FCC?
E. _____

That wasn't so traumatic now, *was* it?

If you selected: mostly A-responses, you're *Mister Keen;* mostly B-responses, you're a cool character; mostly C-responses, you could add tranquilizers to your present diet; mostly D-responses, you're a real *loser*. If you chose to write-in your own responses, you're probably a lot more *creative* than you ever realized, man! ■

Mark III Calibrator

Continued from page 36

on the IC pins, to a minimum. Keep the iron well tinned and complete the soldering to the IC pins as quickly as possible to avoid damaging the IC by excess heat. Also, doublecheck each wire against the schematic before soldering to be sure you are correct. It's difficult to change connections on the ICs. And the extra heat that may be applied because of changes required to correct your wiring can permanently damage the IC.

After mounting and wiring all components on the board, give it a thorough inspection to be sure there are no errors in wiring, cold solder joints, or shorts created by excess blobs of solder or clippings of wire. Mount all of the controls to the housing, taking care not to mar the lettering or the vinyl covering.

Mount the battery holder as shown in our photo and then the circuit card. Use several nuts as spacers to keep the wiring from shorting to the housing. Connect the switches, J1, and the battery to their respective points on the circuit card. You may want to put a dab of red to identify the positive contacts of the battery holder.

Testing and Aligning. Now we're ready to enjoy the benefits of our hard (?) work, but first let's check out and align our calibrator. Insert three AA cells in the battery holder, taking care to observe correct polarity. Before doing so, be sure power switch S2 is *off*.

Loosely couple the output of the calibrator through a 10-50 pF capacitor to the input of a receiver that has been warmed up and is operational. Place output selector switch S3 of the Mark III to the 100-kHz position and turn its power switch *on*. If the unit is working you should be able to pick up strong marker signals at 100-kHz intervals across the band. Next tune in one of the marker signals and turn Ident switch S1 *on*. The marker signal should pulse *on* and *off* about twice a second. Repeat these steps with S3 placed at the 50- and 25-kHz positions and observe markers at these intervals.

If you cannot receive the marker signals first check battery polarity, then for shorts that may have developed in mounting and interconnecting the controls and the circuit card. Then check the circuit around the 100-kHz crystal oscillator. Check the polarity of capacitors C4 and C5, as well as for voltage at pins 8, 9, and 11 of IC1 and pin 11 of IC2. If everything checks out you may have a defective IC, which may have been damaged in soldering.

If you cannot get marker signals when S3 is placed in the 50-kHz or 25-kHz positions, check wiring to IC2. If this proves correct, IC2 will have to be replaced. If you cannot get the identification pulses when S1 is closed, check the switch and also for wiring errors in the 2-Hz multivibrator.

WWV Calibration. To be most useful, the Mark III must be accurately calibrated. Once this is done it should remain on frequency. Calibrating with WWV is very easy to do. Tune your receiver to the 5-, 10-, or 15-MHz WWV signals—whichever you receive best in your location. Set S3 on the calibrator to 100 kHz, loosely couple its output to the input of the receiver, and turn on the calibrator. Adjust C1 until the output of the Mark III zero beats against WWV's signal. That's all you have to do to calibrate the unit. ■

Darkroom to Color

Continued from page 42

It appears too dark and too *blue*, doesn't it? The secret of viewing wet color prints is to use transmitted light, i.e., to allow the light to come through the wet print from the rear. This method is satisfactory for quick viewing, but it's best to dry the print completely before making any color corrections to the filter pack.

We strongly advise referring to the Kodak Color Dataguide for color correction. The color viewing filters contained in the Dataguide are indispensable for modifying the filter pack. However, you can also use a color printing filter or follow the correction guides furnished with the set of filters. With a little practice you can become an expert in modifying the filter pack.

The total cost of converting to color processing should be less than $75.00. This includes the CP-5 processing kit and 25 sheets of Ektacolor professional paper. Since the secret of tray-processing of color lies in the heat conductivity of stainless-steel trays, here's a money-saving tip: Sears-Roebuck has stainless-steel cake pans 9 x 13 x 2 in. for less than $3.00 that are ideal for color processing. ■

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The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, taxicabs, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and the number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE-trained graduates who take the exam pass it. That's why we can afford to back our courses with the iron-clad Warranty shown on the facing page: you get your FCC License or your money back.

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Our files are crammed with success stories of men whose CIE training has gained them their FCC "tickets" and admission to a higher income bracket.

Mark Newland of Santa Maria, Calif., boosted his earnings by $120 a month after getting his FCC License. He says: "Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand."

Once he could show his FCC License, CIE graduate Calvin Smith of Salinas, California, landed the mobile phone job he'd been after for over a year.

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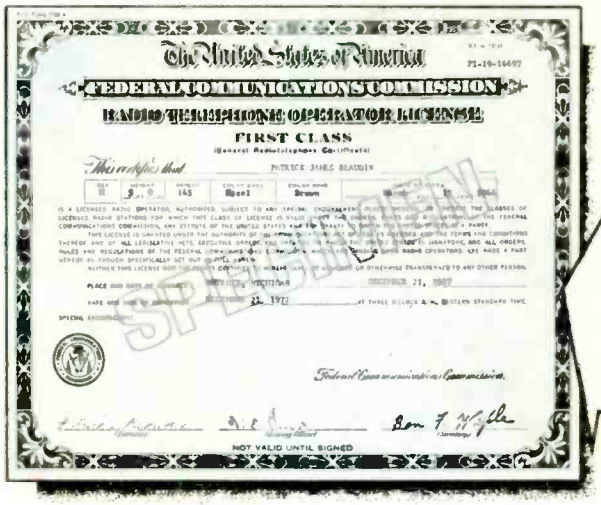

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The Cleveland Institute of Electronics hereby warrants that upon completion of the Electronics Technology, Broadcast Engineering, or First-Class FCC License course, you will be able to pass the FCC examination for a First Class Commercial Radio Telephone License (with Radar Endorsement);

OR upon completion of the Electronic Communications course you will be able to pass the FCC examination for a Second Class Commercial Radio Telephone License;

AND in the event that you are unable to pass the FCC test for the course you select, on the very first try, you will receive a FULL REFUND of all tuition payments.

This warranty is valid for the entire period of the completion time allowed for the course selected.

G. O. Allen

Dr. G. O. Allen
President

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- ★ 12 RECEIVERS
- ★ 3 TRANSMITTERS
- ★ SQ. WAVE GENERATOR
- ★ SIGNAL TRACER
- ★ AMPLIFIER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ EXCELLENT BACKGROUND FOR TV
- ★ SCHOOL INQUIRIES INVITED
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YOU DON'T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the low price you pay. The Signal Tracer alone is worth more than the price of the kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach Yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, Practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, Practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a Professional Radio Technician.

Included in the "Edu-Kit" course are Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector Circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, Plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, coils, volume controls and switches, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, In addition to F.C.C. Radio Amateur License training, You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

Progressive "Edu-Kits" Inc., 1186 Broadway, Dept. 534 DJ, Hewlett, N. Y. 11557

FREE EXTRAS

• SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE + QUIZZES
- TELEVISION BOOK + RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the Professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. What you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

J. Statatis, Of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my Progressive Radio "Edu-Kit" to me, as indicated below:
Check one box to indicate choice of model

- ☐ Regular model $26.95.
- ☐ Deluxe model $31.95 (same as regular model except with superior parts and tools plus valuable Radio & TV Tube Checker).

Check one box to indicate manner of payment

- ☐ I enclose full payment. Ship "Edu-Kit" post paid.
- ☐ I enclose $5 deposit, ship "Edu-Kit" C.O.D. for balance plus postage.
- ☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

City & State ..... Zip .....

PROGRESSIVE "EDU-KITS" INC.
1186 Broadway, Dept. 534 DJ, Hewlett, N. Y. 11557